Achieving Higher SEI Levels

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◆ *Two years or more*
can pass between formal SEI
assessments. An organization
seeking to monitor its progress
to a higher SEI level needs a
method for internally conducting
incremental assessments. The
author provides one that has
proven successful
at Motorola.

M any organizations have turned to the Software Engineering Institute's Capability Maturity Model to improve their software-engineering processes by setting goals to achieve higher SEI levels. This has created the need for an instrument and a process that can be used to evaluate an organization's current status relative to these goals.[1-3] At Motorola, we have developed a method for assessing progress to higher SEI levels that lets engineers and managers evaluate an organization's current status relative to the CMM and identify weak areas for immediate attention and improvement.[4] This method serves as an effective means to ensure continuous process improvement as well as grassroots participation and support in achieving higher maturity levels.

This progress-assessment process is not intended as a replacement for any formal assessment instruments developed by the SEI, but rather as an internal tool to help organizations prepare for a formal SEI assessment. Although I provide examples in terms of CMM version 1.1, both the self-evaluation instrument and the progress-assessment process are generic enough for use with any (similar) later version of the SEI CMM by updating the worksheets and charts used.

We began using the SEI Progress-Assessment method within Motorola's Cellular Infrastructure Group — an organization of more than 1,000 software engineers working on several projects and products for the cellular com-

Score	Key activity evaluation dimensions		
	Approach	Deployment	Results
Poor (0)	• No management recognition of need • No organizational ability • No organizational commitment • Practice not evident	• No part of the organization uses the practice • No part of the organization shows interest	• Ineffective
Weak (2)	• Management has begun to recognize the need • Support items for the practice start to be created • A few parts of 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
Fair (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 in 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
Marginally qualified (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 many 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 of use 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 company	• Pervasive and consistent deployment across all parts of the organization • Consistent use over time across all parts of the organization • Monitoring/verification for all parts of the organization	• Requirements exceeded • Consistently world-class results • Counsel sought by others

Figure 1. Guidelines to rate CMM key activities in CMM version 1.1 or any later SEI CMM version. They were developed by modifying the Quality System Review scoring matrix guidelines to ensure that they address the spirit and themes considered in the CMM. All three evaluation dimensions included in this scoring matrix are equally weighted. You determine the score for a key activity by examining all three evaluation dimensions and their scoring guidelines simultaneously. An odd-numbered score is possible if some of, but not all, the criteria for the next higher level have been met.

munications business — in the second quarter of 1992. A year later, our organization was found to have achieved SEI level 2, the next higher SEI maturity level. This was primarily the result of strong senior-management support, backed by allocation of at least 10 percent of the progress-assessment participants' efforts within a given quarter, and engineer/manager actions taken to implement the process-improvement action plans. These action plans were generated and driven through the assessment method described here.

At Motorola, we found the progress-assessment method offers several benefits. It empowers engineers and managers working within a product group to conduct a self-evaluation relative to an SEI level and create their own list of findings and action plans. This ensures grass-roots involvement in the process and institutionalization of improvement. The process facilitates communication among those involved in this assessment and ensures that important information regarding processes and tools used within the product group is disseminated at the assessment meeting and at subsequent meetings. The process educates engineers and managers — the practitioners — regarding the key process areas and practices listed in the CMM. This increases their understanding of topics in which they may not have been involved in the past, such as software configuration management or software subcontractor management. This also increases the capability of the practitioners in terms of the software-engineering process, methods, tools, and technology. Finally, the progress-assessment process continuously prepares an organization for the next formal SEI assessment.

Some critics of the assessment instrument within Motorola's CIG have said that it focuses primarily on the key activities listed in the CMM without adequately covering other key practices (also called themes) such as the commitment and ability to perform. Responding to input from the CIG's Process Management Working Group, I decided to formally score and track only the key activities, while ensuring that the

scoring guidelines used for determining the key activities' scores account for the additional practices listed in the CMM. For example, to achieve a rating of Marginally Qualified, the key-activity scoring guidelines in Figure 1 require that an organization show the existence of management commitment, have supporting items in place, and monitor and verify use. Also, the progress-assessment process specification requires that findings regarding these additional practices and their associated actions be identified and used as part of an SEI Progress Assessment. This ensures the necessary coverage of these practices.

ASSESSMENT INSTRUMENT

Each SEI level has several associated key process areas. The progress-assessment instrument lets you determine the scores associated with the SEI level your organization is trying to achieve. Each key process area contains several key activities. We created scoring guidelines for measuring how well an organization implements a specific key activity, basing them on several common CMM themes identified by Mark Paulk.[1]
- Commitment to perform
- Ability to perform
- Activities performed
- Monitoring implementation
- Verifying implementation

I then expanded and grouped these themes under three primary evaluation dimensions and developed criteria for evaluating them:
- *Approach.* Criteria here are the organization's commitment to and management's support for the practice, as well as the organization's ability to implement the practice.
- *Deployment.* The breadth and consistency of practice implementation across project areas are the key criteria here.
- *Results.* Criteria here are the breadth and consistency of positive results over time and across project areas.

Scoring. I used the evaluation dimensions and criteria to create guidelines for determining an integer score of 0-10 for each key activity, as Figure 1 shows. Although the guidelines are generic, the assessor can easily use them to determine the score of each specific key activity. This is simpler than having

SEI level 2—CMM v1.1 KPA: Software project tracking and oversight — Organization: ORG_NAME — Date: 15/07/94 — Average score: 4											
List of key activities	0	1	2	3	4	5	6	7	8	9	10
1. A documented software-development plan is used for tracking software activities and communicating status.							X				
2. The project's software development plan is revised according to a documented procedure.				X							
3. Senior management reviews and approves all commitments and commitment changes made to individuals and groups external to the organization.	X										
4. Approved changes to software commitments or commitments affecting software activities are explicitly communicated to the staff and managers of the software-engineering group and software-related groups.					X						
5. The project's software size is tracked and corrective actions are taken.							X				
6. The project's software costs are tracked and corrective actions are taken.	X										
7. The project's critical target computer resources are tracked and corrective actions are taken.						X					
8. The project's software schedule is tracked and corrective actions are taken.									X		
9. Software-engineering technical activities are tracked and corrective actions are taken.					X						
10. The software technical, cost, resource, and schedule risks are tracked throughout the life of the project.						X					
11. Actual measured data and replanning data for the project-tracking activities are recorded for use by software-engineering staff and managers.									X		
12. Software-engineering staff and managers conduct regular reviews to track technical progress, plans, performance, and issues against the development plan.					X						
13. Formal reviews, to address the accomplishments and results of project software engineering, are conducted at selected project milestones and at the beginning and completion of selected stages.				X							

Figure 2. *A sample scoring worksheet. It can be used to summarize the score determined for the key activities of a given key process area, such as software project tracking and oversight, included in the SEI model. These scores are determined using the key-activity scoring guidelines shown in Figure 1.*
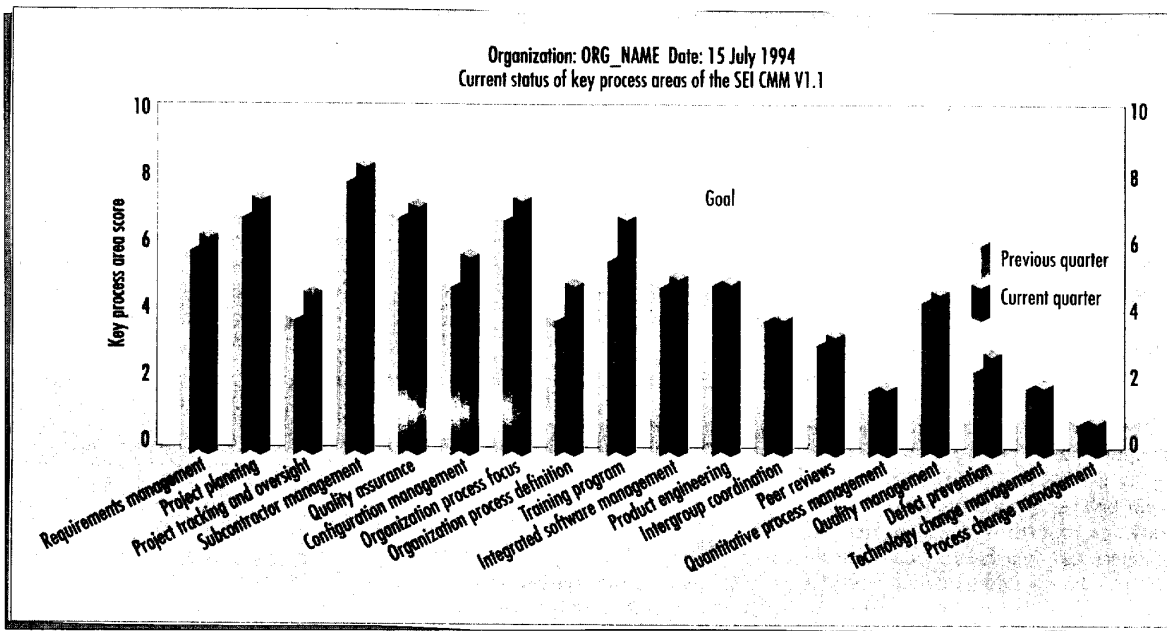
Figure 3. *Summarized progress report regarding SEI key process areas. Bars on the left correspond to the assessment results obtained the previous quarter. Bars on the right respond to the current quarter's results.*

a lengthy list of guidelines, such as one per key activity, which makes the scoring task more complex. The sample worksheet shown in Figure 2 is used to summarize the score obtained by using these guidelines. When applied at the project level, you translate the guideline "parts of the organization," as "subprojects" or "subsystems." When applied at the product-line, division, or group level, "parts of the organization" translates to "projects" or "project areas." Users of this scoring-guidelines matrix must ensure that they use the terms "commitment," "ability," "monitoring," and "verification" as described in the SEI model when determining a key activity's score.

To calculate the score for a specific key-process area, enter the score for each of its key activities in the worksheet shown in Figure 2. Average the individual key-activity scores to find the overall score for that key process area. Within Motorola, a score of 7 or higher for each key-process area at an SEI level i ($1 < i \leq 5$) indicates the organization will likely be assessed at SEI level i by a formal SEI assessment, assuming the organization has already been assessed as being at SEI level i–1. All the evaluation dimensions in Figure 1's scoring matrix carry equal weight when determining the score for a given key activi-

ty. Determine the key activity's score by examining all three evaluation dimensions and their scoring guidelines simultaneously.

Although each evaluation-dimension level represents a two-point increment, the score for a key activity can be an odd number if some of, but not all, the criteria for the next higher level are satisfied. For example, if some of the dimensions for a key process area are rated at the Fair level (4), while others are rated at the Marginally Qualified level (6), a score of 5 would be appropriate.

The average of the key process area scores for a given SEI level indicates how well the key process areas and activities corresponding to that level have been implemented within an organization. The key activities corresponding to each key process area in the CMM[3] are those listed in the sample worksheet. If multiple items are associated with an activity in the CMM, just consider them part of the package that describes the key activity when determining its score.

Low scores identify key activities and key process areas that need immediate attention to raise the organization's software-process capability. A low key-activity, key-process-area, or SEI-level score indicates a problem area that

needs immediate attention and improvement. The next section provides an example of how the problem areas are highlighted within those Motorola business units that already use this method.

DATA PRESENTATION

The organization's current status, as determined using the scoring guidelines shown in Figure 1, are summarized using bar charts and/or Kiviat plots. The bar chart in Figure 3 summarizes the overall status of the key-process-area implementation. Note that a progress assessment and the presentation of the results may be done for a specific SEI level only, instead of all SEI CMM levels at the same time. Typically this is the next higher SEI level the organization is trying to achieve.

You can use Kiviat charts to summarize the status of a key-process-area implementation for a specific SEI level. Figure 4 is an example of an organization's progress in implementing CMM level 2. Each axis starting at the center of the circle corresponds to a key-process area at that level. This chart indicates the progress achieved during the chosen interval — in this case the last quarter — in advancing from level 1

to level 2. The chart also indicates the key process areas at level 2 for which additional focus is necessary, as well as those for which the improvement efforts have already paid off.

The same applies to higher CMM levels. Suppose management is not satisfied with the progress made on Software Project Tracking and Oversight and wants to obtain additional information about the key activities that must be immediately addressed.

Information on implementation status is presented in a bar chart like the one shown in Figure 5. The lower bars on this chart clearly indicate the key activities of the Software Project Tracking and Oversight key process areas that need immediate improvement. These activities include revisions to the development plan, senior management review of external commitments, communication of approved commitment changes, software-cost tracking, tracking software-engineering
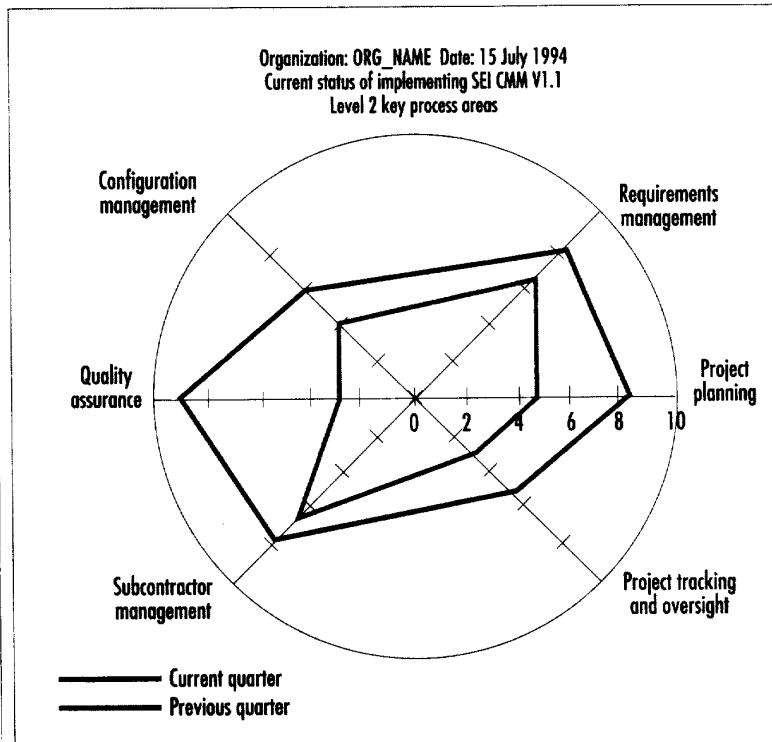

Figure 4. Summarized progress report for SEI level 2 key process areas.
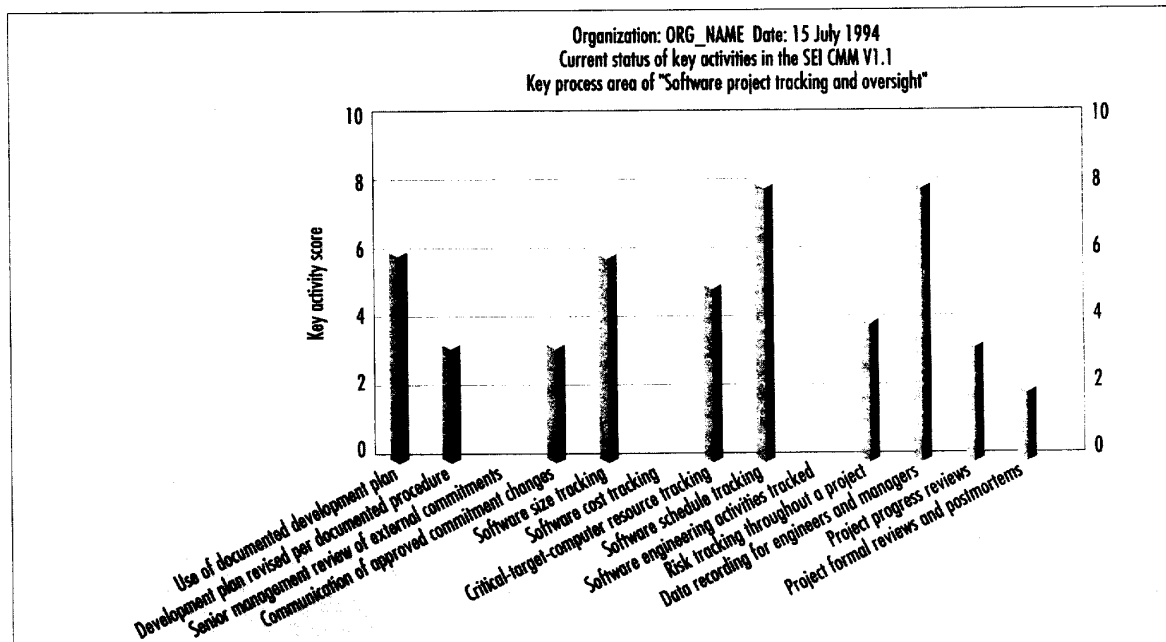

Figure 5. Status of key activities for the Software Project Tracking and Oversight key process area.

technical-activities, project-progress reviews, formal project reviews, and post-mortems. Addressing these items will lead to better performance against the target of reaching higher SEI process-capability levels.

PARTICIPANTS

To be effective, the assessment instrument must be championed and used by members of the organization conducting a progress assessment:
♦ *Organization management.* This role is generally taken by senior management. They are primarily responsible for understanding what is involved in an SEI progress assessment, indicating their support for the whole process, committing resources to implement the action plan created, and following up to ensure completion.

♦ *Progress-assessment champion.* This role is critical. A single individual is responsible for championing the whole process (for the specific time period that it is done), ensuring organization management's support, identifying who within the organization should participate, taking care of administrative items, and championing the action-plan implementation. The champion should be in a technically competent middle-management position that is well-respected within the organization. This role requires a lot of work, and the champion can be involved in progress assessment only for his or her particular organization.

♦ *Progress-assessment facilitator.* This person is responsible primarily for ensuring that the progress assessment runs smoothly, providing consulting support when necessary. The progress assessment includes not just assessment meetings but also action-plan creation and implementation as a result of these meetings. The necessary background for the facilitator includes experience in

conducting assessments and audits of software organizations. The facilitator may be involved in several progress assessments for different organizations at the same time. The progress-assessment facilitator and progress-assessment champion must cooperate closely. The facilitator must be more familiar with the instruments involved and the SEI model used, and have overall experience in evaluating organizations, such as using Motorola's Quality System Review[5] or other audit mechanisms.

♦ *Progress-assessment participants.* The assessment participants are primarily technical and middle-management software people involved in day-to-day software development and maintenance activities. They are not necessarily limited to software developers, testers, and managers; they can also be people working in product management, marketing, or other positions that are part of the overall organization. They participate in the entire progress assessment, including meetings and action-plan implementation.

♦ *Organization-improvement champion.* This person initiates the progress-assessment process during the preparation stage. If no organization-improvement champion exists, one must be identified who will initiate this process. Typically, he or she is also the progress-assessment champion, at least initially, when the progress assessment is introduced to an organization. Once the progress assessment is established, the progress-assessment champion may be changed every quarter to ensure wider participation.

PROCESS

The progress-assessment process provides an ordered series of activities that guide the participants in the use of

THIS PROCESS SPEEDS IMPROVEMENT BY PROVIDING A WAY TO MEASURE AND TRACK IT.

the progress-assessment instrument. The process consists of four stages: preparation, assessment meeting, action plan and commitment, and follow-up.

Preparation. Activities at this stage focus on obtaining management buy-in, if it is not already obtained, and preparing to conduct an effective SEI progress assessment.
1. The organization-improvement champion meets with organization management to present the benefits of introducing SEI progress assessments and recommends their use.
2. The organization-improvement champion identifies a progress-assessment champion.
3. The progress-assessment champion identifies a progress-assessment facilitator.
4. The progress-assessment champion and the progress-assessment facilitator determine the scope of the SEI progress assessment.
5. The progress-assessment champion and organization management select the progress-assessment participants from the projects and groups included in the scope of the SEI progress assessment.

Assessment meeting. During this stage, participants agree on a scoring for the key process areas and activities and a list of strengths and weaknesses in these areas.
1. The progress-assessment champion conducts an overview session for the assessment meeting participants.
2. The assessment-meeting participants prepare for the assessment meeting, record their scores and findings in the worksheets, and forward them to the progress-assessment facilitator.
3. The progress-assessment facilitator uses a spreadsheet (or other tool) to summarize assessment-meeting-participant scores before the meeting.
4. The progress-assessment facilitator identifies a recorder for the assessment meeting.
5. The progress-assessment facilitator moderates the assessment meeting.

6. The recorder creates a draft list of scores and findings.

7. The progress-assessment champion moderates a review of this list.

8. The recorder updates and publishes the list.

9. The progress-assessment champion moderates a meeting with organization management and the progress-assessment participants where the scores and findings are presented.

Plan and commitment. At this stage the participants create the action plan, obtain commitments, and staff the plan according to the results of the assessment meeting.

1. The progress-assessment champion splits the progress-assessment participants into one team per key-process area. These teams generate draft action plans.

2. Each team meets with any existing organization key-process-area champions to ensure coordination and continuity of the action plans.

3. The draft action plans are reviewed and appropriately updated by the progress-assessment participants.

4. The progress-assessment champion ensures that the action plans are tracked using a project-management tool.

5. The progress-assessment champion moderates a meeting with organization management and progress-assessment participants, during which the action plans are presented and input is requested.

6. The action plans are updated on the basis of input by organization management.

7. Commitment templates for all action items are created and filled-in by the teams.

8. The progress-assessment champion ensures that individual meetings are scheduled with department managers to obtain their commitments.

9. Representatives of the teams participate in the meetings with department managers, finalize the commitment templates, and update their action plans appropriately.

Follow-up. During this final stage, participants ensure that the action plan is actually implemented and that sufficient progress is made, which is then reported to management.

1. Regular status meetings are conducted by each key-process-area team.

2. The progress-assessment champion conducts regular status meetings with the progress-assessment participants and provides status reports to organization management.

3. The organization-improvement champion identifies a new progress-assessment champion for next quarter's SEI progress assessment.

We have found that this process accelerates improvement by providing a way to measure it (the scoring guidelines) and track it (the presentation charts). This follows Motorola's approach to software measurement, which states: "Measurement is not the goal. The goal is improvement through measurement, analysis, and feedback."[6] The created action plans are shared with management, and requests for the necessary resources are made so that the actions can be implemented. This happens on a continuous basis, not just once every two years, which is the typical interval for formal SEI or other assessments. In fact, any actions necessary as a result of a formal SEI assessment or a Quality System Review may be folded into the already existing action plans developed through the use of SEI Progress Assessments.

This process also provides a driver for continuous process improvement, in line with the spirit of Motorola's Quality System Review and other process- and quality-improvement initiatives.

LESSONS LEARNED

Management buy-in is essential to a successful implementation of the progress-assessment instrument and process. We introduced both at CIG's monthly Software Process Improvement meeting, explaining what the assessment instrument is and proposing its use to assess current status relative to SEI level 2 and to drive organizational improvement. Motorola CIG's management adopted this proposal and asked that each product group conduct their own self-assessment using this instrument, then create action plans for improvement. Regular action-plan status meetings were also requested and conducted by management to track improvement achieved over time. In the months that followed, we learned several important lessons about implementing this progress-assessment method.

♦ Determine before conducting a progress assessment what its scope is. Also, determine what management level will be considered as "senior" for progress-assessment purposes (director and above, for example). You need this information so that participants can obtain a common understanding of how the SEI CMM description applies to their organization. It also ensures consistency in the use of the scoring guidelines in Figure 1.

♦ Ensure that sufficient coverage is achieved across software-development and -maintenance functions and groups involved. Do this by carefully selecting the participants in the progress assessment of a given quarter. A group of five to six people should be sufficient. However, a larger group of about 20 may be used if you need to increase buy-in within the organization and ensure that the action-plan implementation will be staffed properly. A mix of experienced people who have participated in past SEI Progress Assessments and inexperienced people is recom-

MANAGEMENT BUY-IN IS ESSENTIAL FOR SUCCESSFUL PROGRESS ASSESSMENTS.

mended. In the case of a larger group, special attention is required by the progress-assessment facilitator to ensure that the meetings are sufficiently under control.

♦ To ensure proper coverage of the SEI CMM, use the following guideline: *All* SEI CMM sections for a given key process area, not just the "Activities Performed," should be considered when using the scoring guidelines to determine a score, and when the list of findings and the action plan are created. For example, items under "Ability to Perform" that are not evident in the organization should be listed in the list of findings and subsequently addressed through the action plan created.

♦ The progress-assessment facilitator should use the following method to reach consensus on the score for a key activity and speed up the meeting: Determine what the average suggested score by the participants is, then move higher or lower based on comments by the participants. Do this by first obtaining the individual participant scores prior to the progress-assessment meet-

ing, then use a spreadsheet to determine the mean, standard deviation, and so forth, in advance.

♦ Ensure that the entire progress assessment focuses more on identifying the organization's strengths and weaknesses (the findings) and the implementation of the action plan created and less on what a given key activity's score should be.

I n addition to Motorola's Cellular Infrastructure Group, several Motorola business units have adopted the use of SEI Progress Assessments, including product groups within the Satellite Communications Group, Semiconductor Products Sector, the Land Mobile Products Sector, and the Automotive and Industrial Electronics Group. Thus far, these groups' experiences with SEI Progress Assessments support the lessons learned within the CIG.

After using the progress-assessment process for several quarters, we were able to formally document it, which

implies that it reflects a practically implemented sequence of steps rather than a list of steps that would be nice to do but have not been implemented yet.

Having already achieved SEI level 2 in the second quarter of 1993, work is already in progress for achieving SEI level 3 within the CIG, with the SEI Progress Assessment process continuing to be the key driver. Benefits similar to those reported by Raymond Dion[7] are anticipated as a result of achieving higher SEI process-maturity levels.

The instrument and process used for implementing the SEI Progress Assessment method can also be used in conjunction with additional models of software capability, quality, customer satisfaction, software measurements,[8] and so on, such as the Quality System Review to assess progress relative to "higher levels" in that model. I encourage you to use the SEI Progress Assessment method within your own organization and to share your results with other software practitioners in professional conferences and publications. ◆

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