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The title of this article is actually the wrong question to be asking. The CMMI (Capability Maturity Model Integration) is NOT a set of “bolt-on processes” that last only as long as the wheel is squeaking. The CMMI Product Suite, as noted in previous articles in this series, is a process-improvement approach that provides descriptions of best practices (at a very high level — they’re not procedures) that address productivity, performance, cost and stakeholder satisfaction. The CMMI provides a consistent, enduring framework that accommodates new initiatives and focuses on the total-system problem.

Five process areas are related to process management and six are related to management oversight. The information contained in these 11 process areas assists executives in:

- Focusing on long-term organization viability rather than short-term project and contractual issues
- Establishing a strategic business plan
- Providing and protecting resources for long-term improvement of the organization’s processes

As noted in my previous series of articles for CHIPS, “Five Critical Questions in Process Improvement,” any process improvement program should be driven by and related to some set of business or overarching organizational needs. Use the CMMI as a “check-list,” if you will, to see where existing organizational processes might need some “tweaking” to enhance their effectiveness and efficiency.

Leadership

The role of the leader is at the heart of CMMI-based process improvement. Proactive leadership is the most critical element of any implementation. Bottom-up change is too unpredictable. Organizational change must be designed, implemented as a mission-critical project and led from the top for the following reasons:

- Competing alternative solutions result in piecemeal efforts instead of integrated effort.
- Resources must be committed and dedicated to the process-improvement effort.
- Leaders must establish a mentoring environment for process

improvement, reward process improvement efforts and discourage resisters to process improvement.

- Leadership behavior is watched and emulated.

Leaders must establish and maintain the vision for process improvement. They need to be:

- ✓ Able to see the business need for process improvement and express it in a compelling manner.
- ✓ Willing to personally lead the effort.
- ✓ Capable of changing their own behavior to comply with the new processes and to support others as they learn to comply with them.

Beyond that, the primary function of the leadership is to provide an environment in which process improvement can flourish and enable systematic, continuous process evolution. They can do this by:

- Providing a stable environment which enables process maturation (Level 2) including:
 - Promulgating policies which establish clear expectations with regard to process discipline
 - Requiring key processes to be documented
 - Providing appropriate process and domain training
 - Providing resource levels adequate to permit process institutionalization
 - Reviewing process improvement plans, progress and corrective action
- Establishing an organizational process framework which enables organizational learning and leveraging of good practices (Level 3):
 - Establishing a family of standard organization processes designed to be tailored for specific accounts or projects
 - Establishing an organizational product/process/service delivery metrics database
- Establishing a quantitative management environment (Levels 4/5):
 - Requiring regular reports of summary process/product/service delivery metrics appropriate to the delivery domain
 - Reviewing the utilization of product/process/service delivery data

Leaders can delegate authority, but can never delegate away responsibility. The leadership of the organization must make CMMI-based process improvement a priority and provide the visible leadership necessary to keep process improvement a high priority within the organization. Managing change is a difficult and time-consuming task. Without sufficient top management sponsorship and leadership (which means much more than just mandating “get it done”), process improvement will at best flounder and more likely fail. This will engender a climate that will make future improvement initiatives more difficult to achieve.

Two Models

As described in the first article in this series (Summer 2003), CMMI models have two representations, continuous and staged, which provide alternative approaches (see Figure 1) to process improvement. The continuous representation focuses on process capability — the range of expected results that can be achieved by following a process. Process improvement is measured in capability levels that relate to the achievement of specific and generic goals in each process area. The continuous representation provides

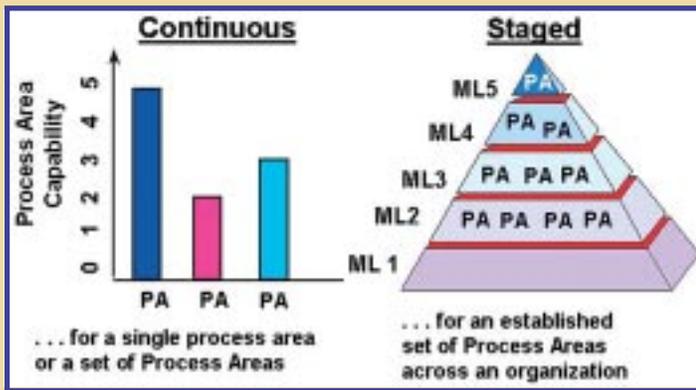


Figure 1.

flexibility for organizations to choose which processes to emphasize for improvement and how much to improve each process. It enables selection of the order of process improvement that best meets the organization's business objectives and mitigates risk.

The staged representation is based on organizational maturity — the combined capabilities of a set of related processes. It focuses on a few key process areas to help an organization prioritize its improvement activities. The CMMI staged model implements this "roadmap" approach to process improvement by selecting a few critical process areas and incorporating the Capability Level 2 generic practices as Institutionalization common features. Note that this view does not imply that a Level 2 organization (or even a Level 1 organization) is not performing some of the practices of the other process areas. In fact, we can assume that it is performing at least some of the engineering practices or it would not be able to produce and sell products.

An organization using the staged representation first focuses on establishing a stable management environment and process discipline so that desirable processes are not abandoned in a crisis. The emphasis is on implementing some basic documented processes so that successful practices can be repeated; some organizational memory is established to reduce the reliance on "heroes" and reduce the risk of unsuccessful organizational performance. At Level 3 the focus shifts from repeatable project performance to an organizational learning mode, so the "good/best" practices can be implemented across the organization, further improving organizational performance by reducing the incidence of "less good" practices.

Which Model?

There has been much debate in the community about the relative merits of the staged and continuous approaches. I believe the debate can be better framed if we look at the differences between process maturity and organizational maturity. Process maturity focuses on the effectiveness/efficiency of specific processes related to various organizational functions. Organizational maturity reflects the underlying management/leadership infrastructure, which supports the ability to make process changes (hopefully improvements) globally and have them "stick" (endure).

The staged and continuous representations of the CMMI are identical at the detailed goal and practice level, except for the base and advanced practices in the continuous representation. Therefore, implementation of the two versions (for the same compo-

nents) will be identical. The only question is the order of component implementation. These priorities will be driven by the needs of the organization, which are a function of the business purposes and current problems.

The continuous architecture has the advantage of providing a fairly well-defined improvement path for a specific Process Area (PA). However, if you have a large number of process areas, it becomes more difficult to provide guidance to an organization that is attempting to rationally allocate limited improvement resources across PAs. Do you focus on a few or try to maintain uniformity of capability levels across PAs or use some hybrid approach? This question needs to be answered in the context of the organization's business goals and objectives.

The advantage of the staged architecture is that the organizational improvement path is well defined in terms of which PAs need attention first. (However, there may be valid business reasons to modify that recommended path.) The Maturity Level 2 PAs focus on getting documented processes in place at the project level. Maturity Level 3 provides a framework of standard processes for leveraging best practices across the organization. Maturity Levels 4 and 5 focus on detailed process and product metrics for control and improvement.

Strategy versus Tactics

The mapping back and forth between continuous and staged CMMIs, while fairly straightforward, can be challenging to inexperienced persons striving to develop reasonable process improvement plans for their organizations. Faced (typically) with limited resources and limited capacity for organizations to embrace and implement changes in behavior, they seek the kind of guidance which is available from staged models. Simultaneously, they are concerned that focusing on only a few process areas may cause them to neglect some other areas whose performance may be critical to organization success.

I suggest that the staged representation be used to develop the process improvement strategy and the continuous representation be used to develop the tactics of process improvement. By this I mean that an organization should, per the staged model, focus on those Level 2 and Level 3 Process Areas that support its business needs (which could include a mandate to become Level 3 for competitive reasons). In general, this will enhance the ability of the organization to establish that environment which will enable lasting process improvement. In developing action plans for specific Process Areas the organization should consider the continuous representation, as this will give it more detailed guidance as to the exact steps that need to be taken to achieve maturity of a given process.

Transitioning from Another Model

Many organizations are concerned with capitalizing on investments they have made using other models. Given that it was derived from existing models which were in widespread use, the CMMI is compatible with a variety of capability and process improvement frameworks as shown in Table 1. Organizations can build on their existing process improvement

Departure Model	CMMI - Compatible	Features Enhanced by CMMI	Additional Features Provided by CMMI
SW-CMM	YES	Core processes are integrated	Systems Engineering and Project Management
EIA-731	YES	Core processes are integrated	Software System Development and Project Management
ISO 9000:2000	YES	Organizational institutionalization	Progressive levels
SE-CMM	YES	Core processes are integrated	Software System Development and Project Management
PMBOK	YES	Core processes are integrated	Systems Engineering, Software System Development and Integrated Project Management
Homemade	Maybe	TBD	TBD
Nothing	YES	Addition of process framework	Provides integrated project processes

Table 1. CMMI Compatibility

infrastructure and use the CMMI as a new set of guiding principles. In particular, organizations transitioning from the Software CMM to the CMMI will need to deal with the following issues:

Level 2:

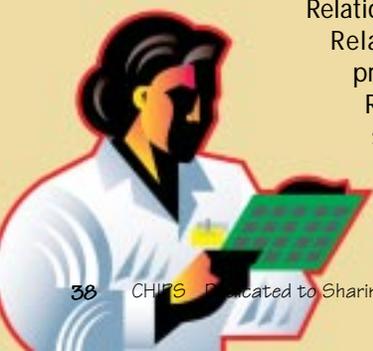
• **Requirements Management** - Traceability, which has always been necessary but not clearly demanded, is now asked for explicitly. Requirements Management is expected to operate in parallel with Requirements Development and offer support as new requirements are discovered and requirements change requests are made.

• **Project Planning** - There is increased emphasis on having a detailed Work Breakdown Structure (WBS). Planning parameters now clearly include:

- Critical competencies and roles needed to perform the work
- Cost of externally acquired work products
- Knowledge and skills training, mentoring and coaching needs
- Capability of tools in the engineering environment
- Level of security required

The identification and involvement of stakeholders is an important evolution of the "all affected groups" statement that appeared frequently in the SW-CMM. The commitment process is now explicitly defined. The required plan for stakeholder interaction includes:

- List of all relevant stakeholders
- Rationale for stakeholder involvement
 - Expected roles and responsibilities
 - Relationships between stakeholders
 - Relative importance of stakeholder to project success by phase
 - Resources needed to ensure relevant stakeholder interaction
 - Schedule for phasing of stakeholder interaction



Data Management (from EIA/IS-731) is now addressed as part of Project Planning for the planning and maintaining of project data items. Their contents have been added to the list of project management concerns. Data Management requires administrative control of project data, both deliverable and non-deliverable. Some large, critical projects demand that even Engineering Notebooks with daily entries be placed under control for audit purposes.

• **Project Monitoring and Control:** Monitoring Commitments have been elevated to the Specific Practice level. Monitoring Risks and Stakeholder Involvement are also more strongly emphasized in the CMMI compared to the SW-CMM. PMC also includes Monitor Data Management.

• **Process and Product Quality Assurance** stresses the objective evaluation of products as well as processes. Evaluation criteria must be established based on business objectives. What will be evaluated? When or how often will a process be evaluated? How will the evaluation be conducted? Who must be involved in the evaluation?

• **Configuration Management:** The idea of a "Software Library" has been replaced by the more encompassing "Configuration Management System," which includes the storage media, the procedures and the tools for accessing the configuration system.

• **Supplier Agreement Management** evolves the initial ideas found in Subcontract Management and incorporates the original intent of Subcontract Management, as well as, lessons learned over the past seven years. It is unlikely to be declared "Not Applicable" in an appraisal, as it now focuses on all sources of supply for projects.

• **Measurement and Analysis** (new) makes crystal clear the intent of the Measurement and Analysis common feature found in the SW-CMM. An organization that barely passes the Measurement and Analysis Common Feature requirements of the SW-CMM would not pass the measurement requirements of CMMI. Using the guidance in this process area, the organization can evolve its measurement program from basic project management measures to those based on the organization's set of standard processes, and then to statistical control of selected sub-processes according to the organization's business needs.

Level 3:

• **Requirements Development (new)** concepts are consistent with very modern publications on Requirements Engineering. It incorporates and expands on the interface ideas of Systems Engineering and Software Engineering with regard to gathering, analyzing, documenting and maintaining requirements found in the SW-CMM. Requirements Development truly shows the recursive and iterative nature of developing requirements: the Requirements Development process area includes a description of developing an operational concept and operational scenarios to refine and discover new requirements, needs and constraints that include the interaction of the product, the end user and the environment. It also includes a strong focus on interface requirements. It suggests the use of models, simulations and prototyping to perform risk assessments to reduce the cost and risk of product development. It is very tightly coupled to the Technical Solution process area and emphasizes the idea

of starting the process of requirements validation very early in the product life cycle.

• **Technical Solution (new)** practices apply not only to the product and product components but also to services and product-related processes. Technical Solutions are developed interactively with product or product component requirements definition. Technical Solution stresses the need for developing alternative solutions. Once the “best” set of alternative solutions are selected it is then possible to establish the requirements associated with the selected set of alternatives to be allocated to the product components. Technical Solution also stresses:

- Product or product component design
- Documenting the complete design description in a “Technical Data Package”
- Designing interfaces
- Performing make, buy or reuse analysis
- Implementation
- Establishing and maintaining product support documentation

• **Product Integration (new)** presents the concepts to achieve complete product integration through progressive assembly of product components in one stage or in incremental stages according to a defined integration strategy. It stresses the careful analysis and selection of the optimum integration strategy. The basis for effective product integration is an integration strategy that uses combinations of techniques in an incremental manner. It points out the need to establish and maintain the environment required to support the integration of the product components. It also stresses the effective management of interfaces to ensure that all interfaces will be complete and compatible.

• **Verification (new)** captures the ideas of using reviews, loads, stress and performance testing, simulation, observations and demonstrations as applicable to ensure that the requirements are being addressed at each phase of the development life cycle from a systems, hardware and software point of view. Peer Reviews are now a goal within this Process Area.

• **Validation (new)** places a stronger emphasis on ensuring that the system will perform as intended in the operational environment.

• **Risk Management (new):** The concepts inherent in risk management finally made it to Process Area status:

- Risk Identification
- Risk Assessment
- Risk Analysis
- Risk Prioritization
- Risk Mitigation
- Risk Contingency Planning

The ideas behind Risk Contingency Planning and Risk Mitigation have been merged but are now clearer.

• **Decision Analysis and Resolution (new)** presents the concepts of identifying alternatives to issues that have a significant impact on meeting objectives, analyzing the alternatives and selecting one or more that best support prescribed objectives. Decision Analysis and Resolution is a new concept for the software world whose time has certainly come. Understanding decision-making models from Operations Research can help in making full use of this process area.

• **Organizational Process Definition** wording has changed subtly but significantly from that of the SW-CMM. “Establish and maintain a usable set of organizational process assets including the organization’s set of standard processes,” acknowledges that an organization may utilize more than one standard process to handle its product lines and business needs. The Process Database evolved into the Organizational Measurement Repository.

• **Integrated Project Management** includes the aspects of Integrated Software Management and Intergroup Coordination that were found in the SW-CMM. The project is conducted using a defined process that is tailored from the organization’s set of standard processes. It also emphasizes the need to integrate the concepts in the Project Plan and all supporting plans such as:

- Quality assurance plans
- Configuration management plans
- Risk management strategy
- Verification strategy
- Validation strategy
- Product integration plans

Levels 4 and 5 Process Areas reorganize and hopefully clarify the Software CMM Levels 4 and 5 practices.

Conclusion

CMMI implementation involves determining an overall process improvement strategy based on business goals and objectives. This article has dealt with a set of fairly high-level strategic issues involved in implementing a process improvement program based on the CMMI. The next article will deal with the tactics of actually developing and implementing specific improvements to processes.

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