



# Creating an Integrated CMM for Systems *and* Software Engineering

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*The Office of the Secretary of Defense (OSD) joined with the National Defense Industrial Association (NDIA) in 1997 to sponsor the creation of a Capability Maturity Model®-Integrated (CMMI<sup>SM</sup>). It would bring together the best features of the Software Capability Maturity Model (SW-CMM) Version 2.0 Draft C, the Systems Engineering Capability Model (SECM) Electronic Industries Association Interim Standard 731 (EIA/IS 731), and the Integrated Product Development Capability Maturity Model (IPD-CMM v0.98). This article describes the CMMI Product Suite that has resulted and what it is designed to provide to the engineering community for enterprise-wide process improvement.*

In 1997 the OSD joined with the NDIA to initiate a project that would integrate process improvement models that would build on the success of the Software Engineering Institute's (SEI's) Software CMM. The Software CMM began as the SEI's answer to a challenge by the Air Force to find a set of key questions about a company's software processes that would guide their selection of the most competent—or mature—software developer. Over several years, that set of questions grew to become the now familiar SW-CMM v1.1.

The systems engineering community had created two models for improvement: the SE-CMM by Enterprise Process Improvement Collaboration (EPIC) and the Systems Engineering Capability Assessment Model (SECAM) by the International Council on Systems Engineering (INCOSE). Those models were later merged successfully to form EIA/IS 731. The two CMMI sponsors agreed that CMM integration would enable the software and systems engineering communities to capitalize on the similarities of their approaches to product engineering process improvement. It also would eliminate some of the differences between the models that had increased the effort—and expense—required to pursue improvement with stovepipe models.

A steering group was formed in 1998. The OSD provided representatives from each of the military services and from the FAA to represent the government. NDIA provided four senior members to represent industry and the SEI provided two managers to round out the team.

Jack Ferguson of the SEI led the Product Development Team (PDT) that was populated with representatives from government, industry, and the SEI. Initially the PDT lacked commercial and international industry participation, but that was

remedied later that year. An initial determination to exclude providers of CMM assessments and training because of potential conflicts of interest remained until the draft material was released for public review in August 1999. Since then, participation has been open to these providers.

The initial concept of the CMMI project was that integrating the three source models—SW-CMM v2.0 draft C, EIA/IS-731, and IPD-CMM draft v0.98—would involve little more than combining the practices of the three into a single document. That led to the expectation that the project could be completed in six months. Project members expected that some challenges would result from the differences in scope and life cycle that the models represented and the different approaches to model coverage. However, the team soon found that true integration meant that they had to deal with differences of terminology and model construction as well. EIA/IS-731, for example, contains a large number of practices that define the systems engineering environment for product development. These practices are all considered normative because they must be performed by the engineering organization. The SW-CMM, however, contains a mix of normative and informative elements, including activities and illustrative information (e.g., subpractices).

Compromises were required in order to integrate these two models. The CMMI-SE/SW that was released for public review reflects the efforts to find common ground.

Probably the project team's most controversial decision was to maintain two representations of each model. Early efforts moved toward a hybrid approach similar to the FAA's choice in the iCMM product. However, the systems engineering and software engineering communities, which had lived with two very different architectures

for the two models, thought it best to maintain a continuous approach from the EIA/IS 731 heritage and the staged approach familiar to SW-CMM users.

## Challenges Ahead

Releasing the first version of the combined model this summer does not end the development effort. This release was intended to provide an initial operational capability (IOC) for organizations ready to begin the evolution to a more broadly capable model for enterprise process. We will seek feedback from early adopter organizations to gather the lessons learned from using version 1.0 of the CMMI models, as well as the return on investment experienced from institutionalizing the more robust practices that populate the combined model.

Adapting the model to address the particular challenges of working in the integrated product and process development (IPPD) environment has led to a variant (CMMI-SE/SW/IPPD) that better meets the needs of organizations in that domain. Initial work to add the acquisition discipline into the model is under way as well.

While the IOC version of the CMMI models will provide the needed markers for beginning the transition from source models to the CMMI models, we know that the model is still in its youth. Until Lead Assessors have had an opportunity to wrestle with the assessment differences between the source models and the CMMI models; we anticipate differences in interpretation, particularly on the more revised practices. As a result, we advise government organizations seeking to use this latest model for assessing the capabilities of potential suppliers to advance carefully.

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Experience also will instruct us as to how to best address the always-contentious area of “tailoring criteria.” The current text adds new information to clarify tailoring as an activity at the project level, working with the organizational standard processes. Historically, the challenge has been seen as organizations wrestle with the applicability of various process areas as they seek to demonstrate a maturity level. We expect organizations to give us feedback to get user perspectives on the subject.

We think that the model is in excellent condition for its intended role as a tool to stimulate enterprise-wide process improvement. Nevertheless, we recognize that there remains a need to use such process tools to benchmark organizational capability or maturity. We expect that refinements from actual use will need to be made to the model, just as refinements were made to the Software CMM when it was introduced. Thus, our plans include a v1.1 in about a year that will be designed to capture needed improvements and recognize the need to evaluate as well as assess—to benchmark for source selection discrimination as well as plan the course toward continuous improvement.

Another new challenge not initially anticipated was to accommodate industry’s interest in providing guidance through an acceptable standards approach. That thinking was best represented by creating the SECM as an Interim Standard, using the stakeholder balloting process to meet the requirements of the American National Standards Institute. The recommendation to merge the EIA/IS 731 material into CMMI meant that we must consider offering the CMMI model and method as a potential replacement standard.

That possibility drove the need to develop a new appendix that contains required and exacted practices of CMMI models without the explanatory material familiar to users of the SW-CMM. As experience builds with CMMI-SE/SW v1.0, we expect to introduce CMMI materials for consideration first as a national standard and then possibly internationally.

## Our Approach

While we have highlighted some key outcomes in the history, in this section we would like to give you a feel for the processes—they were not always as “high

maturity” as we might have liked. Creating the Product Development Team was a specific attempt to include diverse representatives from government and industry with the SEI. Organizations were asked to provide team members rich in experience with the source models and their training and appraisal methods. In many cases, the members had authored portions of the source models, and were seldom shrinking violets about the strengths and weaknesses of the sources and related reference models and directives. One member noted that in a given meeting, one could estimate the number of opinions by counting the number of members in the room and adding at least one. Decisions that favored one model’s features over another always had to be sought by building team consensus. This led to creating the first version, v0.1, which was released to a stakeholder/reviewer group in late 1998. Difficulties were pointed out in the size and complexity of the model, and the team sharpened its pencils to better integrate the material. It was a major step when the team, which had focused on the CMM’s engineering portion, determined that the expanded practice areas inherited from the systems engineering discipline could represent a more complete evolution of the significant portion of product development represented by a single Key Process Area in the SW-CMM, Software Product Engineering.

The release of v0.2 for public review at the end of August 1999 started another round of improvement. By the close of the review period in November, there were about 2,500 change requests. In addition, offerings of the draft Introduction to the CMMI course training were coupled with focus group sessions the following day. Workshops in technology change management and high maturity practices provided similar change recommendations for consideration. Each of the pilots designed to exercise the model and the appraisal method also provided opportunities for feedback and improvement. The Editor Team, led by Drs. Dennis Ahern and Mike Konrad, determined which changes could be accommodated in time to maintain a summer delivery of the product suite, and those that would not be pursued or would be deferred for consideration.

The quality of thoughtful comments made the choices difficult. In some cases

the need to maintain consistency between continuous and staged representations caused some constructions that appeared confusing to the readers. We sought to clean up these for v1.0, but we know there will be room for improvement.

As v0.2 was beginning the review process, the Undersecretary of Defense (Acquisition, Technology, and Logistics) signed a policy recognizing the value of process maturity for the Department of Defense’s developers of software intensive systems. This led to the need to clarify that the CMMI Product Suite was not developed for source selection. We thought that even though the model represented a broader look at engineering development than with any of the earlier source models, the CMMI Product Suite would need maturation to assure comparability of appraisals before it might reasonably be used by the government for evaluative comparison. ♦

## About the Authors

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