Is CMMI Useful and Usable in Small Settings?
One Example

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The Software Engineering Directorate (SED) of the U.S. Army Aviation and Missile Research, Development and Engineering Center (AMRDEC) in Huntsville, Alabama, acquires software-intensive systems and has more than 250 small companies in its supply chain. In order to determine the appropriateness of using Capability Maturity Model Integrated (CMMI®) as supplier requirements, members of AMRDEC SED teamed with the Software Engineering Institute (SEI) to perform a technical feasibility study in 2003-2004. This article presents the motivation, the processes used, and the major results of the CMMI for Small Business pilot from the perspective of the team that worked on the pilot.

We often hear that CMMI® *wasn't built for small companies so it will not work for them*, or some variant of this sentiment. Many people find the CMMI book/technical report intimidating to think about using it. Although it is true that CMMI was not explicitly built for small companies, it is also true that it was not explicitly built for large companies [1]. The experience we obtained from the CMMI for Small Business pilot indicates that CMMI, when applied in a way that responds to the business realities of a small business, can provide small companies with utility.

Small Pilot Company Profiles
Two small companies from Huntsville, Alabama were selected to participate in the pilot:
- **Analytical Sciences, Incorporated (ASI)** specializes in management and technical services with a focus on systems engineering/program management, information technology, engineering and scientific services, and professional and organizational development.
- **Cirrus Technologies, Incorporated (CTI)** specializes in manufacturing and support services with a focus on logistics, engineering, manufacturing, test and evaluation, information technology, security, and intelligence.

At the time of the pilot, each company had around 200 employees. The projects selected for the pilot ranged in size from a one-person project to a 22-person project. CMMI v1.1 SE/SW was used as the reference model for the project.

Key Challenges in Process Improvement for Small Business
We saw several challenges during the adoption pilot in Huntsville. Some were

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challenges that we had hypothesized, some were new insights. Although the pilot was not designed to address all of these challenges, we list them here in the following as a reference to underscore that we acknowledge that there are a diverse set of challenges for CMMI adoption in a small setting:
- Affordability of process improvement is a major challenge.

"Ensure that senior management understands how to interpret appraisal results, both in terms of what they are likely to mean in terms of performance and how they can be appropriately used in marketing concepts."

- Small businesses need to realize payoff quickly.
- Small businesses do not have staff dedicated solely to process improvement implementation: Customer requirements take priority and can cause delays.
- There is minimal structure to leverage from in a small business.
- *The customer rules.* Many small organizations adopt/adapt their business practices directly from their customers or prime contractor.
- If a quality system is either not already in place or is not well-functioning,

process definition efforts are much more challenging.
- CMMI is generally perceived as intimidating, both in size and scope.

Motivation for the Pilot
The AMRDEC SED is one of three Life Cycle Software Engineering Centers in the Army. Established in 1984, the SED is a recognized leader in supporting the acquisition, research, development, and sustainment of some of the nation's most sophisticated weapon systems. The mission of the SED is to provide mission critical computer resource expertise to support weapon systems over their life cycle. This mission is carried out by a staff of approximately 900 government and contractor employees housed in the Army's only facility designed specifically for tactical battlefield automated systems support.

Like many federal organizations, the SED relies heavily upon a contract workforce for the fulfillment of its mission. The two primary SED contract vehicles consist of many companies categorized as small businesses. Currently, more than 75 percent of the companies contracted for engineering services with the SED are small businesses. Since these companies are increasingly involved in the development of significant components for software-intensive systems, their usage of reliable engineering and management practices has become increasingly critical to the delivery of quality products for the Department of Defense (DoD) warfighter.

Pilot Process Overview
The CMMI for Small Business pilot started in July 2003 and culminated in May 2004 with a Standard CMMI-based Appraisal Method for Process Improvement v1.1 (SCAMPISM) Class A appraisal of each of the two pilot companies. The overall process is summarized in Figure 1. Gaps between the organizations' internal processes and CMMI were identified by

engaging in a collaborative session between the pilot team consultants and the practitioners from the pilot companies that was similar to a SCAMPI C appraisal. Based on the results of this analysis, the pilot companies developed and implemented an action plan and updated existing processes to close the gaps found. Where necessary, the pilot companies also developed new processes. Though we initially did not intend to perform SCAMPI A appraisals, the progress made by both companies was such that in January of 2004 we defined appraisal scopes in conjunction with the pilot companies, and in May 2004 we performed SCAMPI v1.1 A appraisals using the continuous representation of CMMI-SE/SW v1.1 at both sites [2]. Both companies achieved their target level profiles, as follows:

- **ASI:** Capability Level 2 for project planning, requirements management, and measurement and analysis, and Capability Level 3 for organization process focus and organizational training.
- **CTI:** Capability Level 1 for project planning, requirements management, and project monitoring and control (given some of the other business challenges that CTI was facing at the time of the pilot, establishing Level 1 processes in these areas was a significant achievement).

Lessons Learned From the Pilot

There are several competencies in process improvement that provide a useful framework for looking at lessons learned from the pilot study. Four of these are included here as a way to organize lessons learned [3]:

- Establishing and sustaining sponsorship.
- Developing infrastructure/defining processes.
- Deploying new processes into the intended use environment.
- Managing an appraisal life cycle.

We have included an additional category of lessons learned in this section: lessons about the CMMI model itself. Those readers who are experienced in process improvement consulting in a variety of settings may recognize our primary competencies as categories that also apply to larger organizations. However, the particular lessons that have been included here are those that we believe are either unique to the small settings environment or are particularly important for a small company to be successful in their improvement efforts.

Establishing and Sustaining Sponsorship
Obtaining and sustaining the executive sponsorship necessary to make applying resources to process improvement activities feasible

- **Lesson 1:** Focus CMMI implementation in areas where the connection between the model's content and the Chief Executive Officer's (CEO) business goals are clearest.

    In a small company, sponsorship often means getting the attention of the owner and/or CEO of the company. In this setting, the focus of the CEO is often on a combination of cash flow management and development of the growth of the company. This implies that any process improvement efforts that are presented must be aligned with the particular financial environment and growth goals of the company.

- **Lesson 2:** Even if you do not have strong quantitative results right away, make sure that the senior management gets periodic progress reports that include the qualitative benefits of the improvement effort.

- **Lesson 3:** Ensure that senior management understands how to interpret appraisal results, both in terms of what they are likely to mean in terms of performance and how they can be appropriately used in marketing contexts.

Developing Infrastructure/Defining Processes
Providing enabling infrastructure to make definition and use of new processes effective

Examples of activities that fit in this category include the following:
- ° Establishing/managing a process asset library.
- ° Establishing/managing a measurement repository.
- ° Establishing/maintaining standards, approaches, and accepted methods for writing process guidance.
- ° Establishing/managing the organization's curriculum for process improvement.
- ° Establishing points of contact or specific groups (e.g., an engineering process group [EPG]) for various aspects of the improvement.

- **Lesson 4:** Even though a formal EPG may be infeasible for small companies, some focal point for coordination is particularly needed to coordinate infrastructure development and sustainment.

- **Lesson 5:** When a well-functioning quality management system is already in place (e.g., based on International Organization for Standardization [ISO] 9001), take advantage of it! The existence of a well-functioning ISO 9001-based quality management system provided a bootstrap for process guidance standards and several other elements of process improvement infrastructure. On the other hand, if there had been no quality system already in place, some time would have been needed to establish and set up procedures for using some kind of mechanism for storing, controlling, and distributing process assets created as part of the improvement effort.

- **Lesson 6:** The tools and practices of the accounting system have a great influence on what is considered doable

Figure 1: *Pilot Process Overview*

February 2008
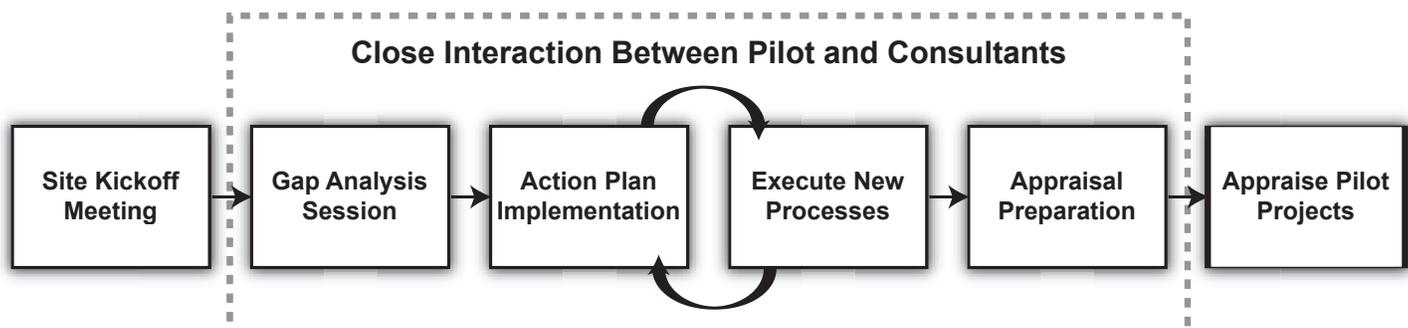
in terms of collecting and using measurements. A small company typically does not have the resources available to create a parallel metrics collection system from their mainstream accounting system, so, at least at the beginning, what is considered feasible in terms of measurement is constrained by what can be collected/aggregated by the tools in use.

Deploying New Processes Into the Intended Use Environment

Ensuring that the new CMMI-informed processes are available to all relevant users and that their successful adoption is associated with appropriate training and job aids. This is where much of what we traditionally call organization change management occurs

- **Lesson 7:** Simple CMMI-based improvements can have a significant impact in small organizations.

    In one case, just adding meeting minutes for the weekly meeting and publicizing them to the customer and project participants (not more than five people total) contributed to more efficient monitoring of the project and improved communication between the customer and the project team. It sounds simple, and it is: The model provided an incentive to try something so there would be records of decisions/status progress. However, the effect was much greater than the project participants anticipated, both in terms of scope of effect and magnitude – the change not only provided an effective tool for monitoring but it also resulted in improved communication with the customer, which greatly improved the performance of the project as a whole.

    Seeing unanticipated benefits from small changes was a great motivator for continuing on the path of improvement and being willing, a little later in the process, to try larger changes. In small companies, the effects of small changes can often be seen much more quickly and the dispersal of knowledge throughout the company about the effects of a change is also faster.

Managing an Appraisal Life Cycle

Selecting a method of measuring progress against a model (i.e., appraisal method) and then planning and executing the tasks associated with the selected method

- **Lesson 8:** Use a focused, *collaborative* appraisal method (e.g., SCAMPI B or

C) for the initial gap analysis. Great benefit is realized by using this session as an opportunity to interpret the model and gain a better understanding of how it applies to the organization.

- **Lesson 9:** Ensure someone in the organization has a good understanding of Appraisal Requirements for CMMI Class A, B, and C appraisal methods and set expectations [4]. This greatly increases the potential for achieving the appraisal objectives defined by the appraisal sponsor.

- **Lesson 10:** Collect evidence that will be useful in the appraisal as you go using automation support as much as possible. Interact with the lead appraiser during evidence collection and mapping to CMMI practices to ensure that a complete, well-organized set of evidence is available for the appraisal. This does not need to be days and days of billable interaction. It may just take the form of e-mailing templates for evidence collection to get an idea of how they fit with the lead appraiser's expectations.

    Although this is one of the lessons that is also equally applicable in a larger setting, the effects if this is NOT done are much greater in a small setting in terms of the percentage of staff time that has to be used to rework material that has been prepared for the appraisal.

- **Lesson 11:** Introduce generic practices once specific practices are clearly understood but prior to the definition and documentation of processes. *Misinterpretation of generic practices is a major cause for appraisal failures.* This is an area where investing in a small amount of external consulting could pay big benefits. In the case of the pilot projects, we held a generic practices workshop to help the pilot participants get a better understanding of the linkages between generic practices and the process areas they were working with.

- **Lesson 12:** Quick looks (e.g., SCAMPI B and SCAMPI C) significantly improve the chances for achieving the objectives of a SCAMPI A.

CMMI Model

- **Lesson 13:** Overall, we saw that judicious use of the elements of CMMI that relate to the business context provided a set of useful practices from which small businesses can benefit, though not always in predicted ways.

- **Lesson 14:** Using the continuous rep-

resentation of the model allowed the pilots to focus on improvements that they perceived as having the highest payoff for the company.

- **Lesson 15:** Changing the practices in the model is not necessary in most cases; finding alternative practices is often relevant. In addition, work products generated as a result of practice implementation rarely match one-to-one to what is suggested in the model.

- **Lesson 16:** *Smallness* was not as much of an issue for model interpretation as the focus of the business. Although both organizations had a more traditional product development project included in their pilot, they also had more pure service delivery contexts (give me a team of N people who can do X for 25 hours per month for the next six months) that they wanted to explore because service delivery is the heart of their business. Sometimes those services are delivered in the context of a project, but they often are not. The model was more difficult to interpret in areas of the pilot involved in service delivery than in the small product development projects. The SEI is involved in an effort led by Northrop Grumman to develop a CMMI for Services (SVC) constellation that may prove more useful in this context. Information on CMMI-SVC can be found on the CMMI Web site at <www.sei.cmu.edu/cmmi>.

A Toolkit to Help You Start Your Own CMMI-Based Improvement Effort

As a major product of the pilots, the team produced a Web-based toolkit that provides details on the processes and assets used in the pilot. (The draft of the toolkit can be found at <www.sei.cmu.edu/cmmi/publications/toolkit/>. It is a draft that was not fully completed due to budget constraints. It may get incorporated into the Implementing Process Improvement in Small Settings [IPSS] Field Guide, in which case it would be updated.) In addition to process descriptions, it provides copies of the actual presentations, templates, and other documents used to support the pilot. It should be treated as an anecdotal set of assets that might be useful in supporting a model-based improvement effort, rather than a canonical set that defines what *should* be used. Having said that, we believe that the toolkit can help people working on improvement in the following small settings:

- Focus their improvement efforts.
- Figure out how and where to get started.
- Tie their improvements to business goals.
- Educate their staff in areas where they may need to improve their knowledge and skills.
- Realize payoffs (mostly qualitative) early in the improvement effort.
- Improve their ability to prepare for appraisals.

The feedback to date that we have received on the toolkit has been very positive and fairly broad in terms of global access (people from Argentina, Israel, United Kingdom, Mexico, and Chile, as well as the U.S. and Canada have accessed the toolkit).

In thinking about using the toolkit, we have a few recommendations for those who are working in small settings currently and are planning to use it to support your improvement effort:

- Think of this as *one* resource to help you, but not the only one. Every month there are new publications related to CMMI; some of them are likely to offer different insights than the toolkit but they may be valuable to you.
- Be sure to read the *What's Missing* section of the toolkit to see if any of the things we talk about in that section apply to you. If they do, then you know you will need resources beyond what we used to get you started and be successful.
- For those of you who are in the DoD supply chain, think about getting mentoring from the larger companies that work with you and have ongoing improvement efforts; they should have a vested interest in your success.
- Keep up with the assets in the CMMI adoption area (<www.sei.cmu.edu/cmmi/adoption>); that is where you will see emerging work on CMMI in small settings in particular and other resources that may be of value to you.
- Explore at a reasonable pace. Unless you have some business investment riding on achievement of some particular status related to CMMI, do not try to do too much at once until you have established what benefits you can accomplish in your own environment.

Next Steps
SED's Plans for Follow-On Activities
The CMMI small business pilot has been one of the most beneficial endeavors of the SED/SEI strategic partnership. We

are pleased that the AMRDEC SED-sponsored pilot provided the stimulus for the establishment of the IPSS project at the SEI. One of the early events of this project was an International Research Workshop in this topic area that was held at the SEI in October 2005 and resulted in an SEI Technical Report summarizing the workshop and containing the papers submitted to the workshop. This report is available for download in the publications section of the SEI Web site [5].

As the SED/SEI partnership continues, we will start to gain insight into the use of some other SEI technologies within the SED setting. These include the insertion of Personal Software Process℠/Team Software Process℠ technology in an Army pilot program to provide the acqui-

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sition organization with greater insight into development metrics. Additionally, the SED/SEI partnership serves an integral role in providing acquisition process improvement support to many of our local Army program managers.

SEI's Plans for Supporting CMMI for Small Settings
The pilot project in Huntsville, Alabama emphasized to the SEI the need for appropriate guidance materials for using CMMI in small settings. In response, the SEI has chartered the IPSS project within the International Process Research Consortium initiative. Seed funding resulted in the International Research Workshop mentioned earlier, and initial sponsors are supporting the prototyping of an IPSS Field Guide that reflects many of the lessons cited here. Contact Caroline Graettinger, the IPSS project manager, for details, at <cpg@sei.cmu.edu>.

Conclusion
We hope you will find this information beneficial as you embark on your own improvement journey and you will become a member of the burgeoning community of practice for CMMI in small settings. Stay tuned with ongoing SEI work in small settings at <www.sei.cmu.edu/iprc/ipss.html>. This endeavor is discussed more on page 27.◆

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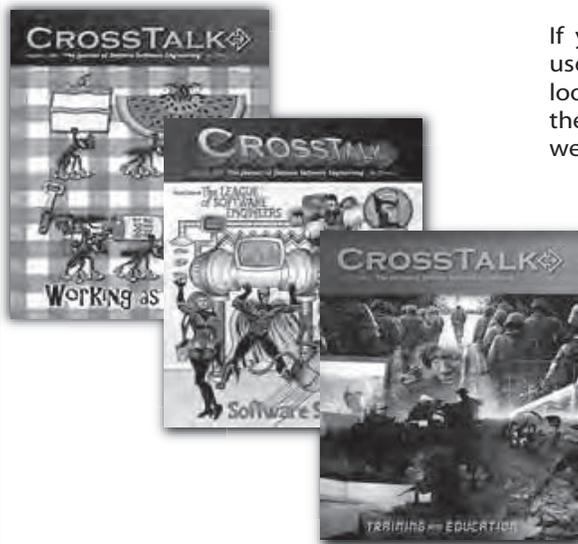
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