The Road to CMMI[SM]: Results of the First Technology Transition Workshop

Lynn Carter, PhD
Caroline Graettinger, PhD
Mac Patrick
Gian Wemyss
Shelly Zasadni

February 2002

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Accelerating Software Technology Adoption Initiative

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SEI Joint Program Office
HQ ESC/DIB
5 Eglin Street
Hanscom AFB, MA 01731-2116

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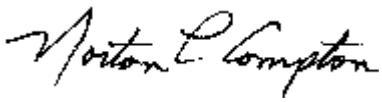

Norton L. Compton, Lt Col, USAF
SEI Joint Program Office

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Acknowledgements

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Abstract

In May 2001, the Accelerating Software Technology Adoption (ASTA) Initiative of the Software Engineering Institute (SEI) piloted a workshop to support the management of technology transition and to capture feedback from adopters of the Capability Maturity Model® Integration (CMMI℠) Product Suite. The workshop, titled "The Road to CMMI: What Works, What's Needed?," served as both a tool for improving the transition of the CMMI Product Suite and as the first pilot of the Technology Transition Workshop (TTW) series.

The workshop was a success, generating 75 prioritized recommendations of what works, what doesn't, and what's needed for an organization to successfully transition to the CMMI Product Suite. Feedback was very positive, with participants indicating that the workshop provided beneficial information they could put into practice at their home organizations. Since the workshop, ASTA's findings have been disseminated to the broader CMMI adopter population through the CMMI Technology Conference and User Group held in November 2001, and the on-going series of CMMI Transition Workshops held in conjunction with the National Defense Industrial Association (NDIA). The findings are also available on the TTW Web site: http://www.sei.cmu.edu/products/events/ttw/. Organizations contemplating the implementation of the CMMI Product Suite, change agents for those organizations, and researchers in technology transition and adoption will be interested in this report.

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1 Workshop Purpose

1.1 A New Technique for Managing Transition

In January 2001, the Capability Maturity Model® Integration (CMMI℠) Product Team and Steering Group, who are responsible for developing, supporting, and guiding the use of the CMMI Product Suite, were looking for ways to increase interaction with the emerging CMMI user community to learn what they were using to transition to the early versions of the CMMI models. They also wanted to know what mechanisms users felt were missing that would be helpful to support the transition. At the same time, the Accelerating Software Technology Adoption (ASTA) Initiative at the Software Engineering Institute (SEI) had identified a need by new-technology developers to monitor transition progress for the purpose of adjusting and replanning their transition strategies and methods. Conversations about these opportunities led to the proposition of a workshop, which eventually became the Technology Transition Workshop (TTW), that would bring users of the new technology, (i.e., the CMMI Product Suite) together to discuss their experiences, methods being used in their implementations, and gaps in their approaches. This information could then be used to

- provide feedback to the technology developers (in this case, the CMMI Product Team) on the state of their technology's transition into the community so that they could leverage successes and plan for corrective action in their transition efforts
- provide an environment for adopters of a new technology (in this case, the CMMI Product Suite) to share lessons learned from their adoption efforts
- disseminate knowledge to the next wave of technology adopters on proven enablers, barriers, and gaps
- provide information to potential SEI Transition Partners on the needs of the CMMI community that the partners may be able to address

These are important for accelerating the transition of an emerging technology because they enable the exchange of information between the stakeholders in a technology's value network. (See Appendix C for a description of value networks and their importance in technology transition.) The TTW was designed to bring stakeholders in the network together into a workshop environment to gather information that is relevant to the other stakeholders in the value network, including the CMMI Product Team. This critical information allows develop-

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ers of new technologies to apply disciplined, manageable practices when transitioning technologies into widespread and routine use.

The initial workshop, "The Road to CMMI: What Works, What's Needed?," was proposed to provide the CMMI Product Team and Steering Group with information about the user community transitioning to the CMMI Product Suite, and to give the SEI the opportunity to develop and test the materials for an ongoing TTW series. The ASTA team is paying close attention to the format, instructions, and materials for future workshops so that the capability to plan and conduct them can be packaged and transferred to other organizations to organize independently.

1.2 Statement of Purpose

The statement of purpose for the initial workshop was:

> *"The pilot workshop will equip the CMMI Product Team and Transition Team with community experience, captured from the workshop, that contributes to the transition success of the CMMI Product Suite. Attendees will share and learn from each other and receive recognition for success."*

ASTA team members worked closely with CMMI Product Team members throughout the planning and organizing stages of the workshop to ensure that the appropriate activities were planned, the appropriate people were involved, and the arrangements would achieve the workshop's goals. Information about the workshop can also be viewed on the TTW Web site: http://www.sei.cmu.edu/products/events/ttw/.

1.3 A Survey to Jump-Start the Workshop

Early on, we decided that it would be helpful to show the workshop attendees what others were doing about their CMMI transitions by collecting survey results ahead of time and sharing them in the workshop. We designed a Web-based survey (available on the TTW Web site at http://www.sei.cmu/products/events/ttw/) that asked CMMI adopters (including prospective workshop attendees) about their CMMI transition efforts and experience. The survey was accessible to anyone visiting the workshop Web site.

There were 161 responses to the survey. Some of the more interesting findings include the following:

- Organization size of those who were transitioning to the CMMI Product Suite ranged from 2 to 72,000 employees, with a median of 350 and an average of 3,369.

- Of those that responded, 43% stated their organization had already made the decision to adopt the CMMI Product Suite.
- About half of those who were committed to adopting it were from organizations that do both systems engineering and software engineering. The other responses included systems-engineering only (3%), software-engineering only (13%), and other organizations.
- When asked about the motivation for transitioning to the model, a common theme among those who answered this question was that it addressed multiple models used within an organization ("multi-discipline") and/or was required by customers or management of the organization ("required.") Others stated that it provided a competitive advantage in bidding for projects against other organizations ("competitive edge") or matched a corporate emphasis on Total Quality Management (TQM) or other quality programs ("quality.")
- From the question that asks about "expected benefits," "multi-discipline" and "quality" were the significant keyword leaders and seem to indicate that the designed multi-discipline characteristics of CMMI are attractive to some users, and that quality is important and is expected as a benefit from using CMMI.
- The models the organizations are migrating from include SW-CMM, ISO9000, "other," ISO/IEC 12207, and the Systems Engineering CMM (SE-CMM). Six companies listed early versions of the CMMI Product Suite under the "other" category. Most of the responding organizations are currently using two or more models.
- When asked what strategy they are using for implementing the product suite, nearly half of the respondents are either "not sure" of their plan or have "no plan yet." Of those with a plan, "CMM leverage," "study/learn," "assessments," and "business-based prioritization" were the most frequently cited strategies. Although they did not explain these strategies in detail, about half of those who will leverage other CMM models said that they plan to finish a specific CMM maturity level before transitioning to the CMMI Product Suite. "Study/learn," "assessments," and "business-based prioritization" may indicate that those who responded will integrate their transition efforts into existing process improvement projects, depending on their business needs. Only 7 of the 161 respondents stated they had a detailed transition plan.
- One-half of the people who responded to the survey provided duration/effort estimates for their transition efforts. Compared to the source CMM models, where experience has shown that it takes an average of 18 to 30 months to move from one maturity level to the next, those that responded expected to take an average of 18 months and 88 person-months of effort for the transition.
- There were only six responses to a question about which CMMI representation they would use, staged or continuous. It appears from the few responses here, and from numerous text answers in the "other" response for several questions, that organizations have not yet decided between the two representations.
- Reasons given for using the staged representation include
  - "Senior managers and customers understand this easier."
  - "We have conducted our own informal survey among our current and potential customers, as well as among government contracting organizations."
  - "Based on what we are hearing, we currently do not see a market for the continuous representation."
  - "At first view, staged seems to best meet our needs."

- Reasons given for the continuous representation include
  - "The ability to choose a process area (PA) based on business objectives in the continuous view."
  - "Our approach is to improve capability continuously rather than reach a maturity level."
  - "Some process areas are important for us and some are not."
  - "May include both representations when we consider the 'software factories' at our geographically separated units."

- Only a few people responded to a question about barriers they have already encountered during their transition to the models, citing the learning curve for fully understanding the CMMI Product Suite and dealing with the transition in the midst of other, continuing projects.
- Anticipated problems included organizational change management issues and managing a different scope of improvement for the new models. The cost of investing in the transition and the lack of information about the value of the new models were described as risks to sustaining the improvement effort.

The picture the survey paints is of a community of organizations that are undertaking the transition from one of several source models to the CMMI Product Suite. Some have detailed transition plans while others are in the very early stages of testing for sponsorship and ownership for the transition, as well as gathering information to determine the best first steps.

The above survey information was described to the workshop participants so that they could assess how the larger community felt about these issues before they began to work on their tasks of identifying "What works?" and "What's needed?" for CMMI transition in their particular cases.

2 Participants and Agenda

2.1 Participants

In planning the workshop, the workshop committee needed to ensure that the individuals who attended were representative of the stakeholders in the CMMI Product Suite's value network. Since the CMMI Product Suite had not yet developed a map of their value network, we discussed and came up with an initial set of stakeholders in the network. While this was not complete or final, it was deemed sufficient for this first workshop. The stakeholders included

- organizations that have started to adopt/transition to the CMMI Product Suite
  - organizations that piloted the CMMI Product Suite
  - Level 5 organizations that are moving from a CMM model (Software, Systems, Integrated Product Development) to the CMMI Product Suite, based on their technology change management capability
  - other organizations that are adopting/transitioning to the CMMI Product Suite who have worked through one or more stages of transition (e.g., as described in the Initiating, Diagnosing, Evaluating, Acting, Learning [IDEAL[SM]] model)
- transition partners who have worked with adopting/transitioning organizations
  - first-hand experience with implementing the CMMI models in organizations
  - personal experience with supporting more than one stage of adoption/implementation (e.g., as described in the IDEAL model)
- CMMI developers, both SEI and non-SEI
- ASTA and other SEI
  - workshop planners and project team
  - workshop work group facilitators

An important criterion was that participation was limited to those organizations that are already implementing a transition process. It was a requirement that any of the organizations that were invited were already transitioning to one of the models from a CMM background or adopting the CMMI Product Suite with no CMM history.

In addition, participants were asked to submit a short white paper about their organization's decision to adopt the CMMI Product Suite. These papers are presented in Appendix A.

[SM] IDEAL is a service mark of Carnegie Mellon University.

The workshop had a diverse group of participants with varied backgrounds who came from the Department of Defense (DoD), commercial, and transition partner domains. Attendees included

- people who had been working with the CMMs for years; others who were coming into this domain for the first time
- members of the CMMI Product Team
- consultants supporting organizations that use the CMMs and the CMMI Product Suite
- organizational Lead Assessors, responsible for transitioning to the Standard CMMI Assessment Method for Process Improvement (SCAMPI) from the CMM-Based Appraisal for Internal Process Improvement (CBA-IPI)
- Software Engineering Process Group (SEPG) leaders who were guiding the use of the CMMI Product Suite
- senior managers active in sponsoring and planning process improvement

One of the participating organizations had started its process improvement program using the CMMI Product Suite; others were moving or had moved to the model from one or more of the legacy CMMs. At least one of the organizations was implementing the model to coexist with SW-CMM-based improvement programs.

The mix of participants was an early indicator of the lively discussions that emerged during the workshop. Multiple perspectives were offered on many of the topics. One participant later commented that the range of experience in the meeting generated many new and interesting ideas.

2.2 Agenda

The agenda was designed to solicit, collect, and synthesize the experience of the participants. Day 1 of the workshop began with participants introducing themselves, explaining their CMMI experience, and presenting their white papers to the group. The participants were then briefed on the CMMI transition survey findings and shown an overview of technology change management concepts. The latter is summarized in Section 3 and the complete briefing is provided in Appendix B. Armed with this information, the participants then approached the first working group task: to identify, based on the white papers presented earlier in the morning, transition mechanisms that other participants were using to move to the new models. Section 4 of this report, “Workshop Results,” describes these mechanisms. In our exercises, all mechanism names were collected whether the mechanisms worked or not. We saved a discussion of the usefulness of the mechanisms for the next day’s workshop sessions. Each group posted the names of their mechanisms on a wall chart according to the stage of the adoption curve (please see Section 3 for information on the term “adoption curve”) where the mechanism was first used. Many of the mechanisms were useful for several of the adopter

groups; however, a rule was established that the mechanisms were to be posted in the adopter stage where they were used *first*.

This first day of work was followed by an expedition to a Pittsburgh restaurant for dinner and awards. We recognized and applauded the workshop participants for their contributions and thus for helping to make the transition to the CMMI Product Suite easier for others.

Table 1: Workshop Agenda, Day 1

Day 1	
Agenda Topic	**Desired Outcome**
Opening Remarks	Understanding of the objectives for the workshop and participant roles.
White Paper Presentations	Participants are familiar with the main points in white papers.
White Paper Q&A	Answer any questions regarding white papers.
CMMI transition survey results	Review and identify CMMI transition mechanisms from the CMMI transition survey.
Technology Transition and Change Management Briefing	Provide participants with a definition of "Transition Mechanisms" and understanding of the transition models to be used in the workshop.
Session 1 Working Group - Identify Transition Mechanisms for CMMI: What Works	Participants identify, provide examples and assess transition mechanisms found in white papers, the CMMI transition survey and the CMMI Product Suite.
Session 1 Working Group - Agreement on Transition Mechanisms for CMMI: What Works	Discussion of each transition mechanism identified and placement on the Transition Mechanisms Table for CMMI by participants.
End of Workshop—Day 1	
Evening Social and Dinner at LeMont	Recognize participant contributions to the successful transition of CMMI.

On the second day of the workshop, the participants reviewed the lists of mechanisms and identified those that were most useful (see Section 4 of this report for details). The “What Works?” list of mechanisms was prioritized according to which ones were perceived to be most important and effective.

Then the participants broke into two working groups and brainstormed mechanisms they wished they had but that were not mentioned in the earlier exercises. The “What’s Needed?” mechanisms were prioritized according to which ones address the most important gaps and thus are the most important to develop.

The participants then compiled a list of approaches to CMMI adoption that should be avoided. This was referred to as “traps and timewasters,” and Section 4 of this report describes this list in detail.

Table 2: Workshop Agenda, Day 2

Day 2	
Agenda Topic	**Desired Outcome**
Session 1 Working Groups—Transition Mechanisms for CMMI: What Works & What Doesn't	Participants evaluate the Transition Mechanisms Table and develop a list of recommended mechanisms for the transition of CMMI
Session 1 Working Groups—Transition Mechanisms for CMMI: What Works & What Doesn't Outbriefing	Working Groups present their list of recommended mechanisms for the transition of CMMI
Session 2 Working Group—Identify Transition Mechanisms for CMMI: What's Needed	Working Groups identify, provide examples, and prioritize transition mechanisms not found (missing) in the Transition Mechanisms Table. Determine placement of missing mechanisms on the Transition Mechanisms Table for CMMI. Prepare and present recommendations briefing of group work.
Session 3 Working Group—Identify Transition Mechanisms for CMMI that don't work	Define and prioritize things that caused or nearly caused transition efforts to fail or to be delayed.

Occasionally, as requested during the workshop, members of the CMMI Product Team or other workshop participants gave demonstrations or briefings on different CMMI-related tools and topics. During the final afternoon of the workshop, members of the ASTA program described their technical program work and demonstrated some of the tools under development to enable, support, accelerate, and evaluate progress in transitioning new technologies.

Table 3: Workshop Agenda, Day 3

Day 3	
Agenda Topic	**Desired Outcome**
Review, discuss, and expand on the results from all of the sessions.	Review and discuss mechanisms presented in each of the sessions.
Closing Remarks	Review of workshop activities and next steps for the CMMI community.
End of Road to CMMI Workshop	
ASTA Demonstrations	Demonstrations of SEI/ASTA technologies created to assist with the diffusion, transition, and adoption of new technologies.

Overall, the planned agenda was followed, with a few improvisations along the way based on the discussions and ideas that developed during the working sessions. We interpreted this adaptation to be a healthy sign that the workshop participants felt empowered to participate and to take up new ideas.

3 Technology Transition Concepts

The workshop's introductions and white paper presentations set the stage for a discussion of "transition mechanisms." However, before beginning to describe those mechanisms, we presented workshop members with an overview of technology change management. This presentation established a common vocabulary about the management of technology change that would be used throughout the workshop, and it introduced the categories we would use later when collecting names of transition mechanisms. The presentation with detailed notes is included as Appendix B.

As we sought a solution to the workshop's objective of identifying mechanisms that early adopters think would improve and facilitate an organization's transition to the CMMI Product Suite, we provided participants with some fundamentals about the common complexity of technology adoption. For example, when managers in an organization decide to change an organization's technology processes, they face some typical problems. As organizational processes tend to be stable and are rarely radically changed, managers may not have the skills to organize and plan for technology change. Moreover, every organization is different and its unique skill sets, maturity, and characteristics must be taken into consideration. For example, introducing a new calendaring system into an organization may impact managers and others who coordinate events in their daily work; introducing a new Integrated Development Environment (IDE) will impact the developers who must use it, but not their managers who don't. The bottom line is that each new technology imposes a different footprint on the organization, and needs to be treated uniquely. However, there are common principles that apply to the adoption of technology. If organizations can address technology change systematically, they can learn to master it.

Workshops such as this one are a tool that can be used to facilitate the deployment of a new technology. These workshops provide a means to communicate with early adopters of a technology, to learn which parts of the *whole product* that the technology suppliers provided along with the technology were useful and which are clearly missing.

The TTW series provides an opportunity to test whether early technology adoption planning is working. It can be provided after the early adopters have engaged with the technology, before the early majority have become engaged, and can help the technology sponsors understand what it will take to get the technology across the "gap" between early adopters and early majority users.

Understanding the need for, use of, and design of this workshop depends on certain ideas about how to accelerate technology transition. In the following sections we'll discuss

- adopter populations and how and why we characterize technology deployment by the needs of the adopters
- what a "whole product" is and what it means for technology transition
- what technology "transition mechanisms" are
- the commitment curve, what it is, and how it is used

The briefing at this point in the workshop covered these ideas to prepare for the subsequent exercises in the workshop.

3.1 Adopter Populations

Work by Rogers [Rogers 95][1], expanded upon by Moore [Moore 91], describes typical categories of technology adopters. The total adoption population is described as a normal distribution with a vertical axis for the number of adopters and the horizontal axis for time intervals.

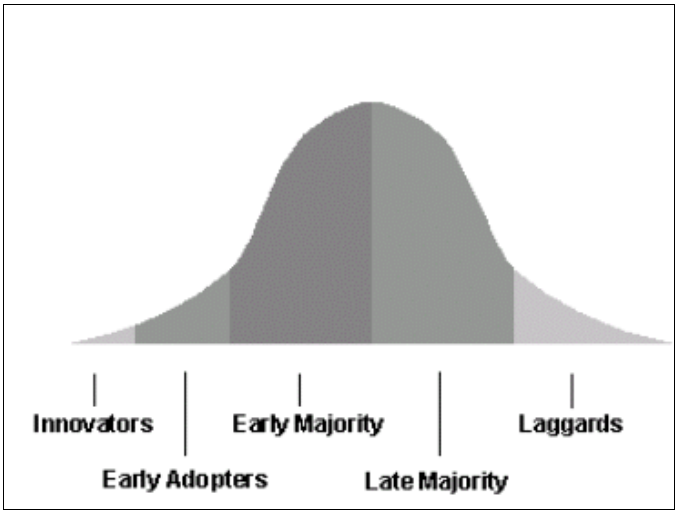

Figure 1: Adopter Populations

Moore describes five categories of adopters, Innovators, Early Adopters, Early Majority, Late Majority, and Laggards, as follows:

- Innovators: technology enthusiasts who like being the first to make something new work.
- Early Adopters: visionaries who have the insight to match an emerging technology to a strategic opportunity, the temperament to translate that insight into a high-visibility, high-risk project, and the charisma to get the rest of their organization to buy into that project.

[1] This work was originally published in 1962, and was recently reprinted in 1995.

- Early Majority: these pragmatists represent the bulk of the technology market. They are not risk takers and only accept a technology after it has proven itself. They prefer return-on-investment information and want to know how others have fared with the technology.
- Late Majority: conservatives who may seem to be, in essence, against discontinuous innovations. They buy and use technology not because of any real belief in the technology but because they feel they must just to stay on a par with the rest of the world.
- Laggards: skeptics who do not participate in the high-tech marketplace and will often block innovations to maintain the status quo.

A number of books and reports describe the characteristics of these five categories of adopters. From the point of view of people who want to encourage the adoption of a technology, getting the technology adopted by the early majority is what can make a technology a success. Innovators and early adopters provide feedback to shape the technology; however, unless the technology provider anticipates and meets the needs of the early majority the technology is unlikely to make it across the "gap" into majority use.

3.2 Whole Products

There are a number of ways to anticipate the needs of the early majority users of a technology. The ASTA Initiative at the SEI provides workshops, technology-planning approaches such as TransPlant, and Web-based adoption tools such as the IDEAL-Based New Technology Roll-out (INTRo) to help individuals and teams anticipate the needs of adopters to support rapid adoption of a new technology. Among the things that these tools and workshops support is the identification of *whole product* components—those things that need to be built to accompany a new technology to meet the needs of the early majority [Moore 91]. Whole product elements include training, case studies, instructions, process guides, or tools. Figure 2 below illustrates these components. By anticipating and providing the components that the early majority adopters will need to adopt the new technology easily and quickly, the technology owners can accelerate the adoption of their technology.

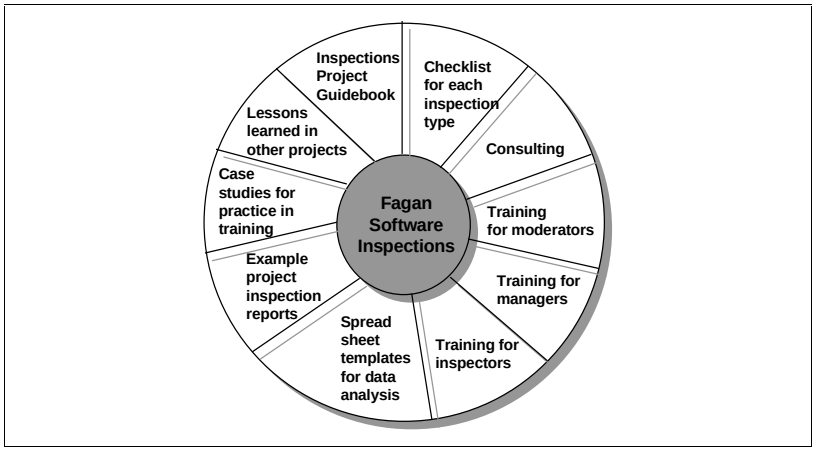

Figure 2: A Whole Product Example [2]

[2] Based on Fagan Software Inspections as implemented at AT&T Bell Labs.

3.3 Transition Mechanisms

The components of a whole product, besides the technology itself, are *transition mechanisms*.

"A transition mechanism is the means by which information, procedures, or skills are communicated. The first category is information dissemination. Examples range from marketing brochures and advertising to engineering handbooks. The second category is technology implementation, where the objective is to alter attitudes or behavior, including new skill sets. Examples here include training courses, revised reward systems, and policy change" [Fowler 93].

A technology transition workshop is most useful after a technology has been introduced. It identifies transition mechanisms by building on the initial set provided with the technology's introduction. The innovators and early adopters will use the mechanisms initially provided and will experiment to find out which combinations work most effectively. The workshop allows the technology owners to meet with those early users (innovators and early adopters) to learn

- which of the initial mechanisms worked well
- mechanisms that didn't work or weren't used
- other things that are needed (with the caveat that things that innovators and early adopters want may not appeal to members of the early majority users)
- how effective their initial mechanism planning was, so that future planning will be more effective

The workshop focuses on transition mechanisms—successful, unsuccessful, and missing. This information can then be used as input for replanning for majority adoption. Some of the missing mechanisms that are identified may be built; or, the information from the workshop may indicate areas for further research.

3.4 Commitment Curve

It is not enough to only discuss mechanisms, or those components that worked to help people adopt a technology such as the CMMI Product Suite. Planning when, how, and why to apply the mechanisms is critical to successful transition. When transitioning technology to an adopter population of innovators, early adopters, early majority, late majority, and laggards, individuals gain commitment to the use of the technology in stages that are often depicted as lying along an S curve, as in Figure 3 below [adapted from Conner 82]. This commitment curve describes an individual's commitment (the vertical axis) to a technology increasing over time (the horizontal axis). Stages in that curve are identified as contact, awareness, understanding, trial use, limited adoption, and institutionalization.

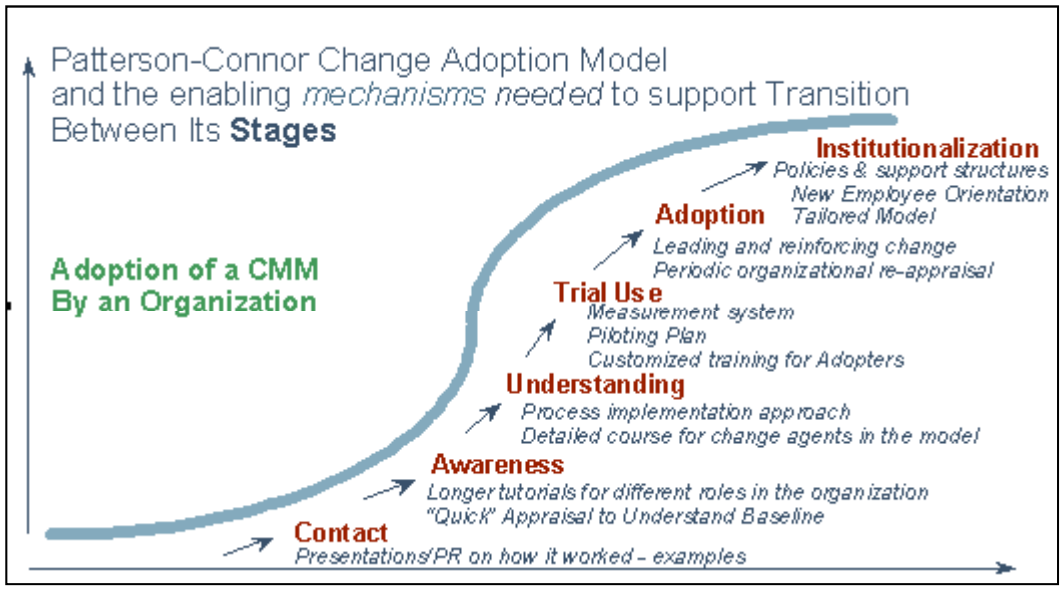

Figure 3: The Commitment Curve

Each member of an adopter population progresses through these stages unless they get stuck or decide to abandon the technology along the way. When the aggregate of adopters in an organization have gone through these stages, we consider the new technology institutionalized and used by the majority segments of the organization.

These stages of commitment are useful for planning the organization's transition to the technology. For example, the mechanisms needed to create awareness probably create excitement rather than explain the technology, whereas, the mechanisms created to support trial use may describe how to identify a pilot user and how to evaluate the pilot results. The "what works?" and "what's needed?" mechanisms identified by workshop participants were categorized into the stages of the commitment curve. This enabled the users of the workshop's results to more clearly understand the use (or intended use) of the mechanisms and the importance of having mechanisms at every stage of the commitment curve. Stages without mechanisms are barriers to successful technology adoption.

4 Workshop Results

The workshop participants generated the following three categories of recommendations for those attempting to implement the CMMI Product Suite and those that support or enable the implementation such as change agents, the CMMI Product Team, and SEI Transition Partners:

1. 60 recommended practices for adopting the CMMI Product Suite
2. 40 mechanisms still needed to improve adoption
3. 30 “traps and timewasters” to avoid

These 130 separate findings and recommendations were prioritized and the 73 most important, as voted on by the participants, include

- 22 recommended practices
- 31 needed mechanisms
- 20 traps and timewasters

These findings and recommendations should enable future adopters to plan and execute more effective technology transitions to the CMMI Product Suite. They also provide valuable input to the rest of the CMMI community, including potential SEI Transition Partners who may use this information as preliminary research on which to base their development of CMMI transition products and services.

4.1 Recommended Transition Mechanisms

Based on their experience, the workshop participants recommended the mechanisms for future adopters that are listed in the following table. The mechanisms were categorized into one of the five phases of adopter commitment discussed in Section 3. Note that mechanisms may be used in several of the phases, but were categorized in this workshop according to the phase of their first use. For example, in the following table, the mechanism “Multiple communication channels established” is helpful in several of the stages of commitment, but its first use is recommended in the Contact and Awareness stage.

Table 4: "What Works" Mechanisms

Stage of Commitment	Mechanism	Votes
Contact and Awareness	Think CMMI; reference cards; promotional materials	14
	SEI material translated into local language	8
	Multiple communication channels established	4
	CMMI awareness briefings/forums held	3
Understanding	Methods for self-assessment; gap analysis; mini-assessments; class B&C assessments that relate gaps to the organization's processes	20
	Chart that describes process responsibilities of different roles/across organizational boundaries	11
	Poster on CMMI	7
	Transition roadmap for the organization	7
	CMMI implementation action plans	4
	Birds of a Feather sessions on focused topics	4
Trial Use	Integrating measurement of PI progress into QA	8
	Linking of the QA process to CMMI	8
	Transition strategy SW-CMM → CMMI	8
	Pilot/trials in non-SW-development areas	7
	Example CMMI process improvement budget	5
Limited Adoption	Role-based training	24
	Tailoring guidance/strategies for different organizational contexts	23
	Transition steering group	10
	ROI trend data	9
	Integrating all disciplines into the process group	8
Institutionalization	CMMI best-practice based templates/checklists/assets	22
	Integrating process review into project management reviews	14

4.2 A Wish List of Future Mechanisms

In the second stage of the workshop, the participants compiled a wish list of transition mechanisms that they would like to add to their arsenal of mechanisms outlined in the previous section. The table below shows the results of the prioritization and the number of votes that each of these mechanisms received.

Table 5: "What's Needed" Mechanisms

Stage of Commitment	Mechanism	Votes
Contact and Awareness	Widely published list of organizations who have decided to transition, to use for source selection	21
	A clear vision of what CMMI is	11
	Integrated product suite across the adoption spectrum, a "whole product"	11
	Well-written PR materials targeting senior managers, project managers, and system engineers	10
	Web-based mechanism linker (e.g. Amazon.com model that recommends mechanisms you might want based on those you've used or asked about)	8
	Clear and unambiguous statement from DoD on what their intentions are for using CMMI for both government and contractor organizations	8
	Statistically-based information to demonstrate that benefit is being derived from using CMMI	7
Understanding	Technical sales pitch, describing the promise of CMMI	10
	Project-supported class C assessment method	9
	Rewritten CMM TRs for CMMI usage, especially reports about measurements and metrics	7
	Expert evaluation of implementation and artifacts for CMMI	5
	CMMI version of Mastering Process Improvement and PCM Method	3
	Guidelines for using core/common PAs in areas not covered by CMMI	2
Trial Use	Tailored transition guides for different transition paths	8
	Guidelines for establishing and mapping the organization's process architecture that are consistent with organization's culture and CMMI	6
	Mapping of organizational roles to CMMI goals and practices	6
	Project-supported class B assessment method	7
	Guide for designing pilots to maximize adoption	5
	Organizational mentoring program	5
	ROI calculator	4

Stage of Commitment	Mechanism	Votes
Limited Adoption	Adoption guide organized by organizational characteristics (domain, size, market)	8
	DoD CMMI assets library (policies, procedures, sharing mechanisms)	7
	Materials to enable people to become CMMI subject matter experts (e.g., black belt)	6
	Training "starter kit" with training design content and role-specific training recommendations	6
	Modern/alternative training mechanisms for CMMI (CBT, VTC, Web-based)	6
	Web site of assets needed for assessment–SCAMPI materials	4
	Method and technology for continuous process assessment/ evaluation	4
Institutionalization	Strategic plan from CMMI Steering Group for transition and product evaluation	5
	Incorporation of CMMI content into Defense Acquisition University curriculum	5
	Guidelines for negotiating interfaces based on customer and supplier relative process maturities	3
	Certification process for CMMI assessments	3

4.3 Traps and Timewasters

This section of the workshop prompted energetic responses from the workshop attendees. The purpose was to capture lessons learned about what not to do to transition an organization to the CMMI Product Suite. We had no idea when we planned this session that this would turn out to be so therapeutic for the attendees. This list was not categorized into the five stages of commitment, but it was prioritized, as the table below shows.

Table 6: Traps and Timewasters

Trap or Timewaster	Votes
Have Process Engineering Group (PEG)/Software Engineering Process Group (SEPG) meetings with no project representation	13
Overdo (e.g., write 100 page procedure) Risk, M&A, DAR Process Areas when going from SW-CMM to CMMI	12
Don't link process to product quality, cost, schedule, and performance	12
Rely on current "Introduction to CMMI" training as sufficient for assessment team training	10
Let experts/zealots write the procedures	10
Set artificial level requirements, and put the people with the lowest estimate in charge	9
Spend most of your time on the open-ended questions during a SCAMPI assessment	9
Don't train–it costs too much. Just do it–follow the assessor	8
Management should dictate process changes without any coordination, because it speeds things up	8
Don't bother to capture the hearts and minds of middle management	8
Select your most important (i.e., crucial) project as your CMMI pilot–get biggest bang for your buck	8
Change the organization structure 6 months before the assessment, to clarify reporting structures	8
Include zealots in specific areas (like measurement, international standards) in your assessment team	7
Tell people they can understand the model just by reading it	7
Align your practices exactly to the CMMI, instead of to what you do	6
Use a benchmark method (e.g. Class A assessment) for first contact	5
Put as many Lead Assessors on your assessment team as possible. Different opinions add spice!	4
Forget the "I" phase in the IDEAL model	4
Use the Introduction to CMMI course as first contact for program managers	4
Rotate your SEPG leader every three months–use someone with a fresh look who has never read the policy!	4

5 Conclusions

This workshop was the first, pilot offering of the TTW series and was a resounding success. The workshop was an exploration of how to design and facilitate future workshops to achieve the following goals in the support of transition management:

- to provide feedback to the technology developers (in this case, the CMMI Product Team) on the state of their technology's transition into the community so that they can leverage successes and plan for corrective action in their transition efforts
- to provide an environment for adopters of a new technology (in this case, CMMI) to share lessons learned from their adoption efforts
- to provide knowledge to the next wave of technology adopters on proven enablers, barriers, and gaps
- to provide information to potential CMMI transition partners on the needs of the CMMI community that the partners may be able to address

For the first goal, the feedback from the CMMI product team leader, who participated in the entire workshop, was very positive. He has since used the results and outputs from the workshop in multiple venues to communicate to the rest of the CMMI Product Team, the Steering Group, and the greater CMMI community the findings of this early CMMI adoption community. CMMI sponsors, senior managers, and key stakeholders have had several opportunities to receive information about what the community believes it needs to continue and accelerate CMMI adoption. These results have been inputs for reassessment of transition plans, whole product development, and transition support for the CMMI Product Suite.

For the second goal, the feedback from the workshop participants was very enthusiastic and far better than we had expected for a pilot. Participants took away ideas that they thought they could apply in their organizations, and heard about barriers and time wasters that they need to watch out for as they continue their adoption efforts.

For the third goal, the workshop findings have been disseminated to the broader CMMI adopter population through the CMMI Technology Conference and User Group, sponsored by the National Defense Industrial Association (NDIA), in Denver, CO, November 2001. The first CMMI Transition Workshop was held in Orlando, FL, January 17–18. For more information about NDIA-sponsored workshops, please see http://www.sei.cmu.edu/cmmi/comm/ndia-workshop.html. The findings are also available on the TTW Web site: http://www.sei.cmu.edu/products/events/ttw/.

The fourth goal, to provide information to existing or potential Transition Partners about opportunities for providing transition-enabling mechanisms, was also accomplished at the CMMI Technology Conference and User Group in November 2001, and through public distribution of this report on the TWW Web site.

Overall, the workshop design used in this pilot, along with sufficient flexibility in the facilitation process to allow for shifts in the agenda as needed, proved to be a successful package. A few improvements, solicited from the participants, will be integrated into the next TTW, to be conducted sometime in 2002. These improvements include

- providing (before the workshop starts) information on whole product mechanisms identified and released by the technology owners, so that their usefulness can be explicitly commented on by workshop participants
- presenting very clear criteria for the participants to use for prioritizing the lists that they develop
- distributing read-ahead materials on technology transition concepts
- understanding and managing perceptions of balanced participation of the various stakeholder communities

During 2002, the lessons learned from a second pilot of the TTW series will be packaged together with guidance, templates, and other necessary instructions so that other organizations and transition partners can implement these workshops as a part of their transition management processes.

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Appendix A White Papers

This appendix presents the original white papers submitted by TTW participants. The following table summarizes the names and organizations of those who submitted white papers. Not all white paper authors were able to attend the workshop. It should be noted that these papers have not been edited but have only been slightly modified for presentation within this report.

White Paper Author(s)	**Home Organization**
Jeffrey Dutton (attended)	Sverdrup Advanced System Group
Geoffrey Draper (attended) W. H. Eyster (attended)	Harris Corporation
Craig Hollenbach (attended) Al Pflugrad (attended)	Litton PRC
Kenneth Funkhouser (attended) Mark Campbell	Concurrent Technologies Corporation
Ron Ulrich (attended) Rick Hefner	TRW, Inc.
SuZ Garcia (attended)	aimware, Inc.
Wayne Sherer (attended) Mary Gregg (attended) Chuck Gordon Alison Ferraro (attended)	TACOM-ARDEC
Bruce Boyd (attended)	The Boeing Company
Working Group 1.5[3]	SEI and other organizations
Winifred Menezes (attended)	Q-Labs, Inc.

[3] This white paper was contributed by a working group from the High Maturity Workshop that was held at the SEI in March 2001. Some of its authors participated in the TTW.

Technology Transition Workshop
The Sverdrup Experience
WHITE PAPER
J. Dutton
May 21, 2001

INTRODUCTION

The 400-person Sverdrup Advanced Systems Group, consisting of a Headquarters and 10 field offices, began the CMMI[SM] path with the CMMI-SW V0.1 in February of 1999. We are scheduled for our Level 3 assessment against the Staged version of the CMMI-SE/SW on August 20, 2001.

THE SVERDRUP LANDSCAPE

Although one sister organization- the Arnold Engineering Development Center- had made significant progress toward SW-CMM® Level 2 compliance when ASG started its CMMI effort, and although our Sverdrup Technology Headquarters was ISO Registered, there was no real process culture evident when we started. Our ASG Field Offices serve all four military Services and other customers- so we also faced significant differences in technical domain and customer cultures. The "organization" we are taking to CMMI-SE/SW Level 3 compliance is scattered across eight states. What this means is that we had to find a way to ensure we were fully aware of and carefully considered each office's requirements for standard process and for tailoring the standard process.

We brought three advantages to this mêlée: 1) Our Vice President is unwaveringly committed to the CMMI effort, 2) our corporate parent, Jacobs Engineering, has developed mature training and process improvement methods that we are using, and 3) a small cadre of personal who have in-depth experience with the SW-CMM.

HISTORY AND ORGANIZATION OF THE CMMI EFFORT

The effort to adopt the CMMI-SW V0.1 was formally kicked off in February of 1999 with the official formation of the SEPG. Our initial goal was to reach Level 3 compliance by April of 2001. The decision to migrate to the CMMI-SE/SW was made in November of 1999. The Engineering Performance Improvement Center was formed the same month to lead the effort toward systems and software engineering improvement. We had an initial assessment "profile" in April of 2000, and have had two more since.

Our assessment date was recently moved out three months to August 20, 2001 by our Engineering Management Council. The reasons for the move focused on improving the quality and detail of our processes and training materials.

The Engineering Management Council (EMC) oversees and directs the CMMI effort- including acting as CCB for the standard process. The EMC is chaired by the Vice President and General Manager of Sverdrup ASG, and its members are the Office Managers, Directors, and others representing key business and infrastructure elements.

The Engineering Performance Improvement Center (EPIC) conducts the CMMI improvement effort. It consists of a Technical Director, an Engineering Process Asset Library (EPAL) administrator, and seven EPIC Field Office Leads chosen and funded in a part-time capacity by the larger ASG Field Offices. Creative work and reviews are accomplished by these people working as the EPIC Technical Committee.

STRATEGIES
In retrospect, we have put in place five separate but interdependent strategies for the CMMI effort:
Standard process development strategy
Cultural change strategy
Deployment strategy
Quality Assurance strategy
Assessment strategy

The most significant issues to address in the standard process development strategy were 1) to ensure that the breadth of technical domains were adequately addressed, and 2) to ensure that our tailoring process accounted for the differences in technical domain as well as size and scope of projects. Our tailoring approach requires the calculation and application of a Tailoring Guidance Factor- which ensures tailoring decisions are made in a consistent and repeatable manner.

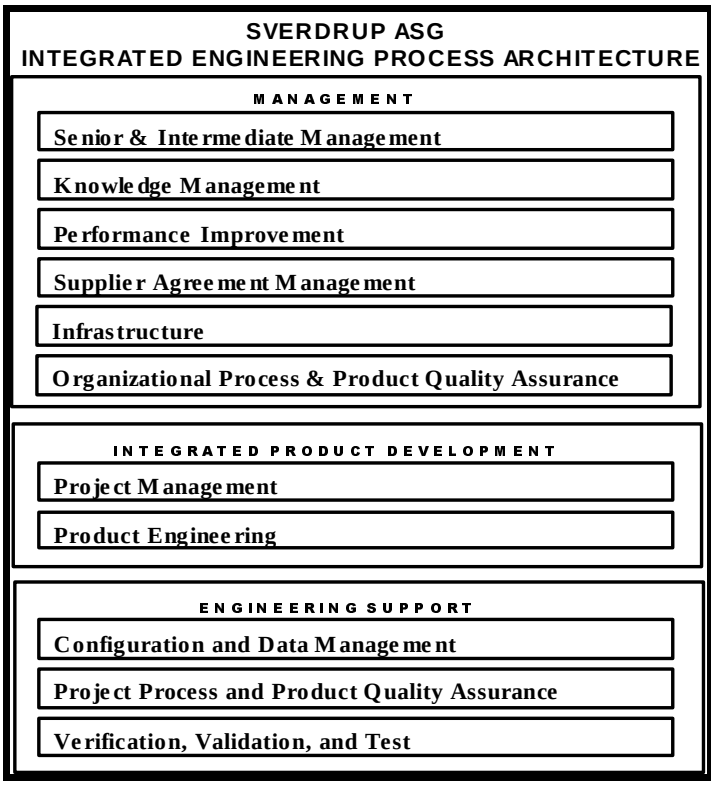
The major challenge in our cultural change strategy was (and is) the movement of management and leadership personnel to a process-literate point of view. The articulation of just how things were done so that we could capture them, then ensure they were CMMI- compliant, was a major effort. Getting business and technical leaders to think in terms of doing things in a standard- although tailored- manner was and is a tough problem.

Our deployment strategy is absolutely key to our success. We decided to deploy the prototype standard process to four Pilot Projects in the fall of 2000, and have used the lessons learned to complete the detail and revise the standard process. In addition, we have elected to deploy the baseline standard process to a controlled number of projects across ASG to ensure continued success and compliance. At the same time, all ASG engineering and engineering management personnel receive the entire suite of training courses- so that they are prepared to implement the standard process when called upon to do so. A “full compliance” date is being set- beyond which all applicable projects and organizational units must be compliant with the CMMI through our standard process.

The quality assurance strategy was confronted with three challenges: 1) ensure compliance with CMMI and standard process 2) encourage and support improved processes and technologies in response to organizational goals, and 3) find a way to fund both of these in a funding-constrained environment. We have done all three.

Our assessment strategy was put in place to conserve assessment funding while reducing the risk of finding unknown problems at the point of our Level 3 assessment. We elected to forego a Level 2 assessment in favor of two additional profiles (ARC Class C assessments).

STANDARD INTEGRATED ENGINEERING PROCESS (SIEP)
In order to provide a sharper focus on engineering and engineering management processes important to the organization, we modeled our Integrated Engineering Process Architecture on the ISO 12207 framework. We defined 12 core processes, which was later reduced to 11. They are shown below.



This set of core processes exhibits several important attributes. It helps us focus on the "mission" processes of Project Management and Product Engineering. It separates engineering support from product engineering- and it provides core process "homes" for important organizational functions. To implement these core processes, we have developed six elements that define the Standard Integrated Engineering Process. These are:

- Engineering Performance Improvement Program Plan (EPIP Plan)- contains the standard process for process development, deployment, and management, as well as the current-year plan for milestones, schedule, and resources.
- Knowledge Management Plan- contains the standard process for knowledge management/ training and the annual plan for execution.
- Quality Assurance Plan- contains the standard process for quality assurance as well as the annual plan for the QA program.
- Measurement and Analysis Plan- contains the standard process for metrics.
- Purchasing Manual- contains the standard process for supplier agreement management.
- Integrated Engineering Handbook- contains the standard process for Project Management, Product Engineering, Engineering Support, and most engineering management activities.

IMPACT ON CULTURE AND INFRASTRUCTURE

The realization that the CMMI (any version) has an impact on EVERY part of an organization came as a bit of a shock. Changes to our training organization, to our IT group, to our proposal process- and a technical relationship with our time-card accounting system, are examples. We are evolving from an organization that has grown at the rate of 30% per year through the efforts of technical and business leadership to one that will now follow a rigorous engineering and management model to

do the same thing in a standard and repeatable manner. The impact has been and continues to be significant.

COMMUNICATIONS CHALLENGES AND SOLUTIONS

The organizational difficulties associated with the first-time adoption of a capability maturity model are magnified by the geographic separation of our field offices. Each major office has a fairly unique customer base, and a unique set of engineering and management values and experiences.

Communication is required at management and technical leadership levels to develop, coordinate, verify, maintain, implement, institutionalize and improve the standard process and associated technologies. Our technology solution is our Distributed Work Environment, discussed below.

The organizational communications solution is based on the EMC and EPIC, and the relationship between the two. In order for our CMMI implementation to work, each EPIC Field Office Lead must lead CMMI adoption in their location, and must work closely with the local manager to ensure all local concerns are satisfied.

ENGINEERING AND MANAGEMENT ARTIFACTS

The following artifacts are used by the indicated parties:

- Action Directive: A highly structured mechanism for assigning actions, resources, and due dates, and allowing the assignee to negotiate and commit to the action as planned or negotiated. Follow-up and closure is required. Used by Senior, Intermediate, and Project Managers.
- Defect Removal Form: Used to document and track to closure all “in phase” problems in documents or software. Applied during Peer Reviews, Unit Test, and Integration Tests by the responsible engineer.
- Problem Report/Baseline Change Request: Used to document all “out of phase” problems with baseline products or documents.
- Standard Operational Project Reviews: Pre-formatted monthly reviews by each Project Manager to the Organizational Unit Manager. Includes applicable project metrics.
- Process Improvement/Feedback Form: Used by anyone in the organization at any time to suggest an improvement to the SIEP.
- Waiver Request: Used by Project, Intermediate, or Senior Managers to request a waiver to training requirements or to the implementation of the SIEP.
- Knowledge Base Assignment Form: Used as agreement between each engineering or engineering manager and his or her supervisor to assign duties so that training courses can be assigned for the year.
- “Executable” word templates for all engineering plans and documents.
- Deployment Plan template: Used to deploy all SIEP documents or changes to those documents.
- Metrics database switchboard and forms

TOOLS AND TECHNOLOGIES

The center-piece of the Distributed Work Environment (DWE) is a data-video conferencing capability that is internet accessible from all of our locations and that provides a high degree of information protection. The DWE also includes the EPAL, and a configuration management system for process engineering documents. The DWE supports the following functions:

- Process engineering (EPIC): process development, hosting, and configuration management. Data-video conferencing and advanced CM tools.
- EPAL: Hosts the Engineering Process Asset Library for organizational, intermediate and project processes, artifacts, and metrics.
- Training: Supports internet-based distributed training and testing.
- Reviews: Supports EPIC and Project Management reviews.

TRAINING APPROACH

As our long term approach, we have adopted a Knowledge Management approach. Year 2001 solutions are centered on a more traditional training/testing solution- but we plan to evolve toward a more active KM approach during the latter part of 2001.

CMMI CONCERNS

Our overall experience with the CMMI has thus far been very positive. Our concerns lie in an area already well known to the community- and where evolutionary solutions are being trailed. We would like to see the cost of assessments and evaluations continue to go down (both to the organization and to the evaluating organization in the case of evaluations). We also believe that, as both assessment and evaluation methods evolve, strategies and methods should be available to dramatically reduce the costs associated with process state measurement and reporting.

Required information:

Jeffrey L. Dutton
Technical Director, Engineering Performance Improvement Center
Sverdrup Advanced Systems Group
4717 University Drive, Suite 101
Huntsville, AL 35816
Phone 256-426-0324
Email: jeff.dutton@att.net or duttonjl@sverdrup.com

CMMI Transition at Harris Corporation

Geoff Draper
Engineering Process Group
Harris Corporation
Government Communications Systems Division
P.O. Box 37, M/S: 2/9702
Melbourne FL 32902
gdraper@harris.com
(321) 727-5617

W. H. Eyster
Vice President – Engineering
Harris Corporation
Government Communications Systems Division
P.O. Box 37, M/S: 2/6500
Melbourne FL 32902
heyster@harris.com
(321) 727-5500

Process Improvement History

CMMI[SM] transition at Harris Corporation follows a lengthy history of CMM-based process improvement. Harris divisions have been aligned with SEI and SW-CMM®-based process improvement since the Harris Information Systems Division (HISD) first became a SEI software process affiliate in 1989. CMM-based improvement initiatives have been most mature in Harris government contracting divisions (7 SPA / CBA IPI SW-CMM assessments and 2 SE-CMM assessments across 4 divisions), but are also used as an improvement framework in Harris commercial divisions (1 CBA IPI).

Following a Harris restructuring in July 1999, the majority of the company's U.S. government contracting business has been consolidated into Harris Government Communications Systems Division (GCSD). Most recently, GCSD completed a CBA IPI in January 2000 revalidating a SW-CMM Level 3 maturity level rating achieved by two legacy divisions in 1994 and 1995. Currently, GCSD is actively pursuing a SW-CMM Level 4 rating through deployment of a division-wide measurement initiative.

Harris has no direct experience with EIA/IS-731, but has been using its predecessor SE-CMM as a basis for systems engineering process improvement for several years. SE-CMM assessments were performed in 1996 and 1997 within two GCSD legacy divisions.

Similarly, Harris has not formally used the IPD-CMM, but has substantial project experience with Integrated Product Team (IPT) environments, and intends to adopt the IPPD component for its CMMI transition path.

A summary of the GCSD process improvement history is depicted in Figure 1.

[SM] CMMI is a service mark of Carnegie Mellon University.

® Capability Maturity Model and CMM are registered with the U.S. Patent and Trademark Office.

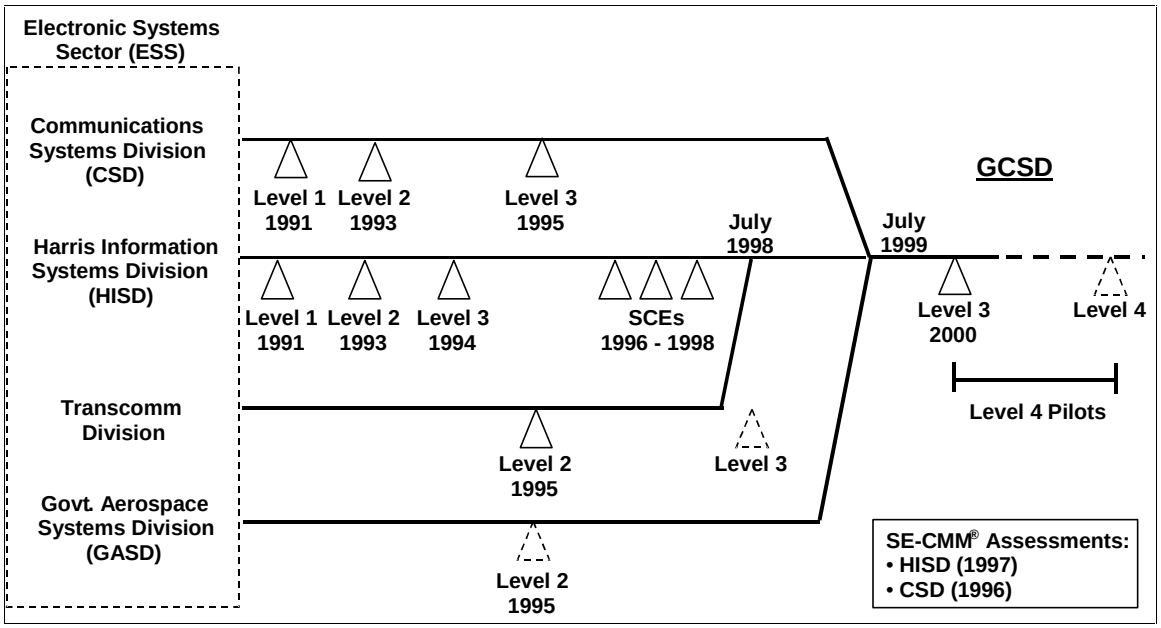


Figure 1. Harris GCSD Process Improvement History

GCSD Process Improvement Structure

Specializing in the areas of airborne, spaceborne, and ground-based communications, Harris GCSD develops and produces information processing and communications systems to collect, store, retrieve, process, analyze, display, and distribute information for the U.S. Government, its agencies, and its prime contractors. With the consolidation of these several prior divisions, the diverse set of GCSD application domains includes areas such as space and ground based communications systems, satellite communications, weather systems, image processing and visualization, signal processing, optical processing, avionics, phase array antennas, and precision structures. Projects include a variety of new development, R&D, and Operations & Maintenance (O&M) programs, which range from COTS integration to custom hardware and software development. The GCSD engineering community consists of over 2600 engineers, including systems (500), software (500), RF / analog (250), electrical digital/network (300), signal and optical processing (150), mechanical (500), logistics (200), and technicians (200).

This diversity in engineering disciplines and application domains has been a primary consideration in the GCSD decision to adopt the CMMI-SE/SW/IPPD model as a basis for engineering process improvement. Cross-disciplinary process improvement has been a Harris practice that began with HISD expanding its SEPG into an Engineering Process Group (EPG) upon achieving SW-CMM level 3 in 1994. The GCSD EPG now consists of 8 engineering discipline teams: Software, Systems, Electrical, Mechanical, RF / Antennas / Optics, Integration & Test, Specialty / Support Engineering, and Engineering Information Technology. An Engineering Process Council (EPC) consisting of senior engineering management and staff guides GCSD engineering process improvement.

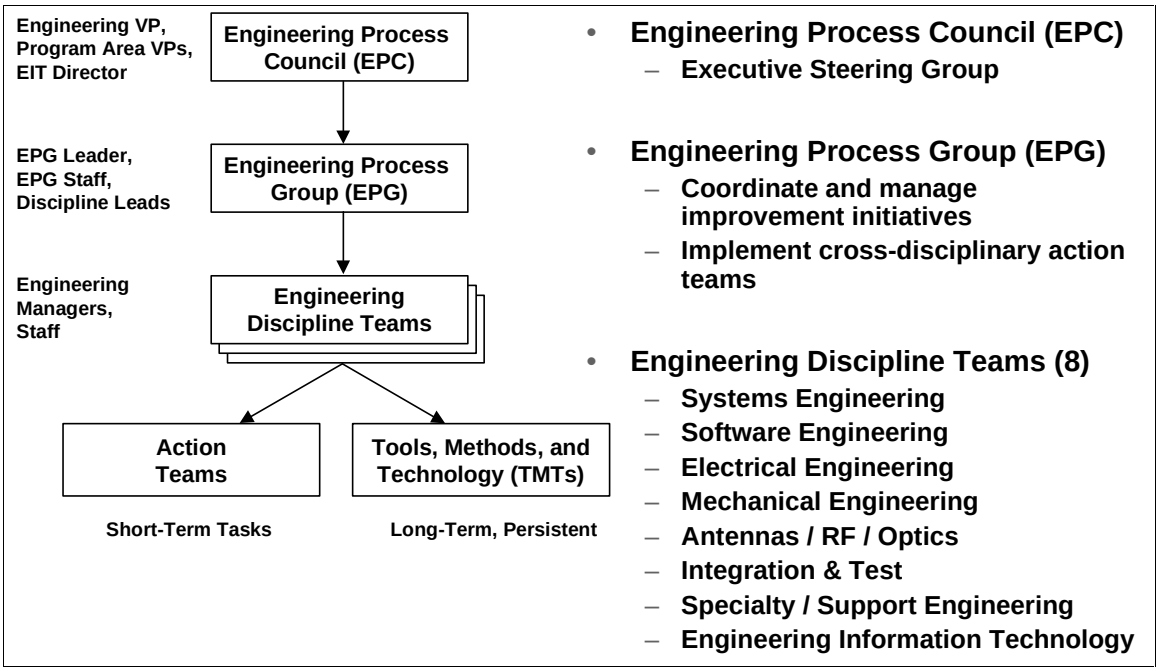


Figure 2. GCSD Process Improvement Structure

Harris CMMI Transition Strategy

A roadmap describing the Harris GCSD transition strategy for CMMI adoption is depicted in Figure 3. A brief description of the components of this plan is contained below.

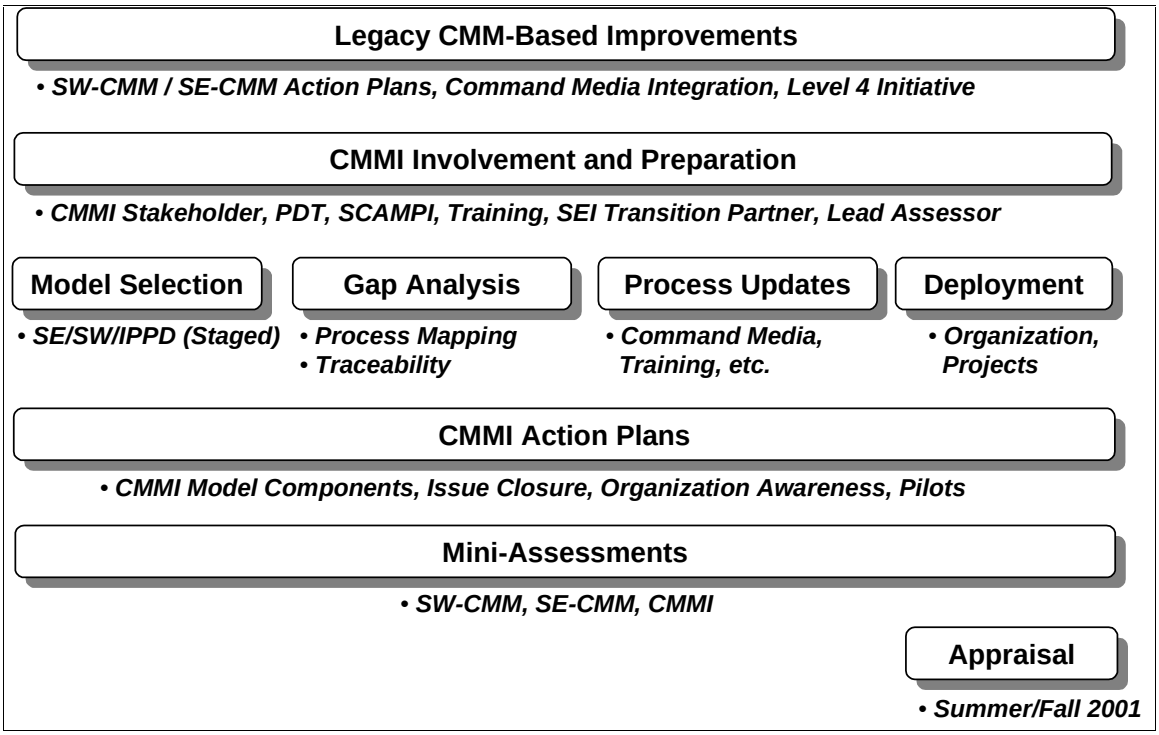


Figure 3. Harris GCSD CMMI Transition Roadmap

Legacy CMM-Based Improvements

CMMI represents a natural evolution from Harris investment in legacy systems and software process improvement models (SW-CMM v1.1, SE-CMM v1.0). GCSD has also developed an internal HW-CMM for structuring hardware process improvement initiatives in selected situations with strategic business value or customer emphasis. As part of its ongoing process improvement strategy, GCSD has established process improvement action plans for each of its engineering disciplines. Based on years of metrics data collection, the ROI from CMM-based improvement is a key factor attributed to improvements observed in engineering productivity and quality.

This applies not only within the government market, which demands a demonstrated level of process maturity and proven performance in order to compete for new business, but ongoing CMM-based improvement and transition to CMMI is also planned within certain of the Harris commercial divisions due to similar business needs and market demands.

Even though CMMI has introduced additional process areas and practices, CMMI is fundamentally consistent with these legacy models. GCSD therefore believes that current improvement initiatives based on these still make strategic business sense, and investments will migrate naturally to CMMI. Most notable in this regard is the ongoing GCSD SW-CMM Level 4 initiative, which includes deployment of a division-wide measurement framework and integrated metrics database. Recently 3 pilot projects have validated via mini-assessments to be operating in accordance with Level 4 practices, and the pilot program is being expanded to 4 additional projects.

CMMI Involvement and Preparation

Harris has long been involved in the CMMI project, as a stakeholder reviewer since August 1998 and Product Development Team (PDT) member since February 2000, and currently as co-lead of the CMMI Assessment Methodology Integrated Team (AMIT). In addition to helping develop a process improvement framework that can be viably used across industry for internal process improvement and external capability evaluations, this has provided GCSD with early visibility and insight into the details of the CMMI models and how they can be used effectively to strengthen and guide improvement of GCSD engineering processes.

Harris has been accepted as a CMMI transition partner for internal delivery of SCAMPI assessment services and Introduction to CMMI training instruction. Harris currently has one SEI-authorized CBA IPI lead assessor, and is planning to seek authorization for two SCAMPI lead assessors.

Model Selection

Harris GCSD intends to migrate to a staged representation of the CMMI-SE/SW/IPPD model, due primarily to market preference, legacy investment, and familiarity with the SW-CMM within the GCSD engineering and management community.

Harris commercial divisions adopting CMMI intend to migrate to the continuous representation of the CMMI-SE/SW model, due to its flexibility in selecting process areas and capability levels for improvement based on business value. However, since several of these organizations are early in their process improvement lifecycle, a hybrid approach is also recommended using the equivalent staging of the continuous representation for initial pursuit of staged level 2 process areas before migrating to a fully continuous representation approach for focusing ongoing improvements.

Gap Analysis and Mini-Assessments

The GCSD EPG is currently utilizing an internal mini-assessment technique to determine the organizational mapping and gap analysis as part of its transition effort based on the CMMI-SE/SW/IPPD model. The Harris mini-assessment process is a consensus-based approach that has been used for several years within GCSD and Harris commercial divisions as an efficient, effective, and low-cost mechanism to identify strengths, weaknesses, best practices, and improvement opportunities relative to a CMM-based model. A description of this mini-assessment process for the SW-CMM can be found in the October 1999 issue of Crosstalk (http://www.stsc.hill.af.mil/CrossTalk/1999/oct/natwick.asp), but essentially provides traceability from CMM practices to organizational/project command media, and assigns a rating (0-10) for each practice in terms of:
Approach – the extent to which the practice is described in organizational/project process descriptions
Deployment – how consistently the practice is implemented and institutionalized
Results – the effectiveness and positive results realized from deployment of the practice

The mini-assessment process has been adapted for CMMI by incorporating each CMMI specific practice and generic practice, establishing traceability to where the practice is implemented in the organizational command media, identifying sources of objective evidence, and assigning ratings in each of these dimensions. This effort is being implemented initially by the GCSD Systems Engineering and Software Engineering discipline teams (reference Figure 2), with facilitation by the EPG. Results of these mini-assessments are being used to establish CMMI action plans to address the assessment findings.

Initially focused only on SE and SW disciplines at the organizational level, the CMMI transition strategy intends to extend the CMMI mini-assessment process to additional disciplines, and to division projects upon deployment of the revised CMMI-compliant organizational processes.

The Harris CMMI mini-assessment process can be characterized as an ARC Class C method. Based on several years of use, this mini-assessment has proven effective in identifying the key process strengths, weaknesses, and improvement needs for both organizational and project processes. It also provides an excellent indicator of the projected results for future internal or external appraisals, with considerably less effort and organizational impact than formal appraisal methods.

Based on this experience, Harris recommends that other organizations consider a variety of assessment approaches in determining their CMMI process improvement path, rather than relying solely on SCAMPI Class A assessments. Class B and Class

C methods can be a much more cost-effective approach, with relatively little compromise in assessment accuracy or basis for improvement initiatives.

CMMI Action Plans

Findings from the CMMI gap analysis and mini-assessments are used to identify and prioritize GCSD improvement initiatives. In accordance with its defined processes for SW-CMM Level 3, GCSD follows its Engineering Process Improvement Handbook (EPIH) to plan, execute, and manage engineering process improvement activities. A transition plan is used to establish long-range strategic improvement initiatives based on business objectives, internal / external appraisal findings, and internal improvement requests. These goals are used to determine prioritized tactical initiatives, developed annually with the EPG and EPC. Individual improvement activities are developed by the respective engineering discipline teams or EPG, depending on breadth of coverage, with overall cost/schedule management provided by the EPG leader.

Several mechanisms are being used to increase organizational awareness of CMMI within the GCSD engineering and management community. This includes delivering briefings and lunchtime forums on the CMMI model and components, intranet web pages, and status briefings on GCSD CMMI transition and improvement initiatives.

GCSD has also printed and distributed copies of a pocket-sized CMMI Reference Card to its engineering and management population, as part of encouraging the organization to “Think CMMI”. Softcopy source for the reference card, in PageMaker format, was obtained from SEI.

Although Harris is a transition partner for delivery of Introduction to CMMI training, the primary delivery of the full training course is anticipated to be as part of SCAMPI assessment team training. Typically, Harris does not offer the full CMM-based model training to its general engineering community; rather, overviews are incorporated as applicable into standard engineering process training courses and briefings. However, additional full training courses may also be offered to other Harris divisions.

Process Updates and Deployment

Updates to the organizational command media are planned to incorporate the improvements developed by the GCSD CMMI action plan. This includes such assets as process descriptions, training, checklists, and templates. A Configuration Control Board (CCB) is established to manage improvement requests to GCSD process media and assets, using change requests documented in a Problem / Improvement Tracking Report (PITR).

Based on the scope of the improvement activity, piloting is typically used to validate improvements prior to organization-wide deployment.

Upon incorporation of CMMI-related improvements into the organizational process and project defined processes, the GCSD mini-assessment process will again be used to assess the implementation, deployment, and results of CMMI transition efforts at the organizational and project level. A custom database is being developed

to document and manage findings from mini-assessments, internal SCAMPI process improvement assessments, and external capability evaluations.

Appraisal

Following initial implementation of the GCSD CMMI transition plan, a Class A SCAMPI assessment is planned for late in the 2001 calendar year.

Summary Recommendations

Based on experience with CMMI transition at Harris Corporation to date, the following lessons learned and summary recommendations are offered as guidance to other organizations pursuing similar initiatives:

Start early!
- Understand the differences from legacy models and methods.
- Identify gaps and establish action plans.
- Do not underestimate the organization learning curve.

Continue current improvements based on legacy models
- Do what makes sense for your organization.
- Investments will migrate naturally to CMMI.

Consider opportunities to implement integrated engineering assets
- Policies, processes, training, metrics.
- Reinforce with templates, checklists, etc.

Use a variety of assessment methods (Class A, B, C methods)
- Techniques such as mini-assessments can be effective and cost efficient.
- Class A (SCAMPI) assessments may not always be the most appropriate choice.

Litton/PRC, McLean, Virginia

Maturity Level	5
Date of Assessment	March 2000
Lead Assessor(s)	Joseph Morin, Integrated System Diagnostics, Inc. (ISD)
Point of Contact	Al Pflugrad (pflugrad_al@prc.com)
Web Page	www.prc.com
Size of the Organization	5500 employees, 2500 are within the scope of SW-CMM efforts
Typical Program Size	6 people per project, where the typical project is a single-year or annualized task order. 50-200 KSLOC/year
Primary Application Domain(s)	Litton/PRC spans two major domains: Software and Services for National Defense Systems Software and Services for Civil Government Systems

In March 2000, PRC received a PRC-wide level 5 rating in which the assessment team rated at the practice level for all process areas in the SW-CMM v1.1 model. This major milestone is the last of many. PRC initiated model-based process improvement in 1993. PRC sites attained level 2 in December 1995 and PRC sectors achieved level 3 in June 1996. PRC developed a combined SE/SW model-based program in June 1997 and secured its initial ISO 9001/9902 registrations in May 1998. In addition to other ISO registrations, PRC received a PRC-wide level 3 rating in June 1999.

PRC's integrated many different quality approaches into one multi-faceted quality infrastructure: CMM-based process improvement, quality improvement (Qualtec TQM), ISO 9000, Quality Assurance, Customer Satisfaction, and Employee Satisfaction. The quality improvement facet contains the foundational principles, teams, and methods upon which all other facets are built. PRC has pioneered the integration of the SE-CMM, SECM, and SW-CMM, and has participated in the development of the CMMI framework and associated models and representations.

ROI and Improvement Trend Data

PRC's budget for engineering process improvement has exceeded $1M per year since 1993. This figure is supplemented by various line expenditures. The following characterize the business benefit PRC has received since its first process capability baseline (September 1999):

- Defects in delivered documentation are down 78%.
- Defects in delivered code are down 70%.
- Defects found operationally are down 60%.
- PRC's ability to estimate costs on a monthly basis has increased 32%.
- PRC's ability to meet monthly cost goals increased by 40% (CPIm is .977; 1.000 is where planned monthly costs equal actual monthly costs).
- PRC's ability to meet monthly schedule goals increased by 7% (SPIm is .980; 1.000 is where planned monthly schedule equals actual monthly schedule).

Barriers to Achieving High Maturity

To achieve level 4, PRC had to overcome several barriers.

First, PRC needed to resist applying level 4 only to software-related activities. Instead, we adopted the level 4 requirements to the broader business issues of profitability and business development based on past and present performance. These business issues transcended software development and yet still could be applied to it. PRC worked to select the few goals and measures that were most meaningful to all projects and that had a sufficient stream of continuous data.
Secondly, PRC needed to resist applying only organizationally mandated goals and measures on projects. Through pre-assessment consultation, PRC realized that quantitative management should be applied to a project's "points of pain." When projects discovered that quantitative management could address the very real problems they were facing, resistance to implementation changed to enthusiasm.

Thirdly, PRC needed to think quantitatively - to value quantitative management and to see applications of it to existing problems. While this ability comes with practice, it was difficult to envision the end result during initial implementation of level 4 principles.

Unique or Distinguishing Practices
Some distinguishing practices of high maturity organizations include: performing process improvement for business reasons, not just process maturity goals; managing by fact; respecting people; applying process improvement principles to non-model areas; reducing and simplifying processes and process assets for widespread use; and leveraging corporate infrastructure, past improvements, and best practices.

People and Cultural Issues
On one hand, PRC has historically maintained that the principles of quality organizations can be applied regardless of the organizational process maturity. That is why PRC implements respect for people, managing by fact, continuous improvement, and customer satisfaction as foundational principles for all projects and teams.

On the other hand, as PRC's process improvement program has matured, it has had to maintain momentum and move from a program targeted to innovators to one targeted at the majority of managers and staff. Process improvement personnel are now assigned to various levels of management, much as contract and HR personnel are.

Continuing Improvement
PRC is actively pursuing improvements to increase project performance within its major business areas. First, PRC is implementing widespread use of quantitative management within all organizational units. PRC management has begun rollout and review of PRC-wide quantitative project management initiatives for given types of projects and values during monthly operational reviews. Secondly, PRC is adding processes and process improvement support for non-model process areas like information assurance, COTS integration, network management, transition planning, database administration, etc. PRC believes that the CMMI is a process framework flexible enough to add support for these engineering processes, and therefore, PRC is actively transitioning to full CMMI implementation. Thirdly, PRC is pre-tailoring corporate processes to program units to reduce or eliminate the amount of tailoring necessary at the task order or small project level within our business domains. Finally, PRC is refining its internal assessment methods to include: 1) targeted as-

sessments using a subset of CMMI process areas within the continuous representation, and 2) informal interim assessments based upon periodic QA process audits.

Summary

To quote Winston Churchill, level 5 is not the end; it is not even the beginning of the end; but it may be the end of the beginning. Level 5 gives an organization the tools it needs to independently and continuously address and resolve its own business issues. Specifically, level 5 gives PRC the ability to manage by fact, to quantitatively increase performance, and to provide process power to each employee.

Concurrent Technologies Corporation (*CTC*) National Security Division (NSD) Transition to CMMI-SE/SW White Paper April 23, 2001

Submitted to:
Software Engineering Institute (SEI)
Carnegie Mellon University
Pittsburgh, PA 15213-2890
TTWseries@sei.cmu.edu

Submitted by:
Concurrent Technologies Corporation (*CTC*)
100 *CTC* Drive
Johnstown, PA 15904-1935
Mark R.L. Campbell, Kenneth V. Funkhouser
(814) 269-6872, (814) 269-2709
campbelm@ctc.com, funkhouk@ctc.com

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INTRODUCTION

This paper provides a brief background of *CTC*'s extensive company-wide quality initiatives. These initiatives were based on the International Organization for Standardization (ISO) 9001 Quality and the ISO 14001 Environmental Management Systems standards and the NSD's previous initiatives to achieve Maturity Level 2 (L2) of the Capability Maturity Model for Software (SW-CMM). The Division's current transition to the Capability Maturity Model Integrated for Systems Engineering/Software Engineering (CMMI-SE/SW) is discussed in detail. The Division's diverse project and product types present significant challenges for transition to and implementation of the CMMI-SE/SW. NSD's approaches to application of the model in a Research and Development (R&D) environment, to include tailoring guidelines, configuration management challenges, quantitative measures and quality control should be of particular interest. The paper includes discussions of the Division's approach to institutionalizing the use of CMMI-SE/SW principles and the methods used to strive for organization-wide participation.

Background - *CTC*'s Quality Initiatives

ISO 9001/14001

CTC manages programs and performs technical services that are critical to national competitiveness and defense objectives. This work requires quality products and services across a wide variety of domains. In August 1998, *CTC* became the Nation's first not-for-profit company to be concurrently registered to ISO 9001 and ISO 14001 Quality Standards.

Numerous procedures were developed and implemented, ensuring that quality is built into all phases of *CTC* products and services, including Quality Planning, Design Review, Project Planning, Product Development and Delivery, and Project Review. *CTC*'s internal Web site provides employees easy access to this information, in addition to *CTC* Quality Management System (QMS) newsletters, audit results, and QMS/Environmental Management System (EMS) training presentations.

Capability Maturity Model for Software Implementation

In 1998, *CTC*'s National Security Division embarked on an effort to apply SW-CMM principles to software projects under the Division's auspices. This effort focused on developing

SW-CMM compliant NSD processes within the existing *CTC* ISO 9001/14001 QMS/EMS framework.
NSD used an organization-wide approach to develop and implement SW-CMM principles. The effort culminated in a CMM Based Assessment for Internal Process Improvement (CBA-IPI) that assessed the NSD at SW-CMM, Version 1.1 Maturity Level 2 in September 1999. After the CBA-IPI, the NSD initiated an action plan to progress to SW-CMM Maturity Level 3 (L3).

TRANSITION TO CMMI-SE/SW
The majority of the NSD's programs are Department of Defense (DOD) related. The programs are highly diverse, ranging in nature from Service projects (trade studies, consulting, etc) to Systems Development projects (projects that involve hardware/software development).

In March 2000, the Software Engineering Process Group (SEPG) recommended a transition to the CMMI-SE/SW based on the model being more applicable to the diverse NSD programs. NSD Senior Management agreed, and established a Transition Team that included four members. Three members had SW-CMM L2 experience and one had SW-CMM L3 experience, in addition to experience adapting SW-CMM L3 Key Process Areas (KPAs) to include Systems Engineering. The team focused on developing policy and procedures. The team also functioned as the SEPG action arm. The Software Engineering Process Group name was changed to Systems Engineering Process Group to emphasize the broader scope of systems engineering.

Using the Software Engineering Institute's (SEI) mapping example, team members mapped the CMMI-SE/SW L2 and L3 Specific/Sub Practices to existing *CTC* ISO 9001/140001 Procedures, Work Instructions, and to the existing NSD SW-CMM L2 processes and procedures. Regular weekly mapping meetings were used to study and discuss specific Process Areas (PAs), which led to a gap analysis. The team built a spreadsheet documenting 500 issues requiring modifications to existing procedures and creation of new procedures.

Project Types and Diversity
The Division's diverse programs presented a challenge to develop a standard process with effective tailoring guidelines. Working with the SEPG, Senior Management made key decisions regarding the tailoring of the new model to our projects. The NSD General Manager decided early on that Service programs would only follow the procedures available in *CTC*'s ISO 9001/14001 arsenal.

Ultimately, we defined NSD Programs as falling into two project types, one of which has three categories.

- Service: Follows *CTC* ISO 9001/14001 compliant process/procedures
- Systems Development: Follows *CTC* ISO 9001/14001 procedures and NSD CMMI-SE/SW compliant processes and procedures
  - Basic Research and Development (R&D)
  - Applied R&D/Technology Demonstration
  - Applications Engineering/Product Development

Tailoring Guidelines for Systems Development Projects
All NSD Systems Development programs are tailorable. The NSD Standard Process describes how a program can apply tailoring guidelines. The guidelines correspond to the project's category, size and other thresholds as defined in supporting documents.

The project stages (conceptual, preliminary, critical, and final stage) also affect tailoring guidelines. During the Conceptual Design Stage, a Project Plan is required. This plan includes all required areas, some of which may be discussed at the macro level. The areas may evolve into separate plans as projects progress through the stages.

Project-specific tailoring guidelines are implemented based on the Project Manager's direction and NSD Quality Assurance Lead consultation. Managers tailor plans to meet specific needs, eliminating a percentage of a procedure without requesting permission. If a threshold is exceeded, the SEPG must review and approve the proposed tailoring.

Plan Completion Timeline Examples
A project that accomplishes Basic R&D could remain in the Conceptual Design Stage, constantly generating alternative solutions. This project usually has broadly defined requirements and no deliverables other than a paper or a rough breadboard.

An Applied R&D/Technology Demonstration project may cycle between the Conceptual and Preliminary Design Stages. Generally, requirements are loosely stated at a macro level. The stakeholder set is generally larger than that of Basic R&D and use of the end product is typically more formal.

An Applications Engineering/Product Development project generally has better defined requirements than the two R&D project categories. End products may be a finalized requirements set, a prototype or demonstration system, or a final end product.

Tailoring Disagreement Handling Process
The Project Manager and QA Lead discuss proposed tailoring. If disagreement about the tailored process, procedure, or plan remains, it is referred to the SEPG for review. If consensus cannot be reached through the SEPG, the General Manager makes the final decision.

Configuration Management
Rigid Flexibility
The transition team recognized the necessity of "rigidly flexible" plans. This approach to Configuration Management (CM) was due to our diverse "product lines." Major programs often have multiple tasks, which are aligned as subordinate projects. In this case, CM can be handled consistently for all sub-projects or specifically for each sub-project.

Web Configuration Management Considerations
Web-based projects typically involve database, web architecture, and interface or presentation data. The presentation data can change every two to six weeks. Managing rapid life cycle change demanded a new approach. In this case, only macro components may be under CM, such as the database and architecture. Major components changes must undergo a Configuration Control Board (CCB) process. "Presentation data" is managed as regular data. Depending on the criticality of the content data, it is backed up weekly, daily, or even hourly.

The client often calls for rapid changes to the presentation data. Changes are handled as data modifications. The call is documented on a standardized form. The Project Manager and the

client review changes. Two servers, “staging” and “live” are in use. Modified presentation data are placed on the staging web server for testing and access is given to the stakeholders.

Team members test modifications to presentation data on the staged server, ensuring changes do not affect “live” data. Once stakeholder feedback is obtained, the presentation data is migrated to the live web server. When no feedback is available, the Project Manager can approve data transfer to the “live” web server.

Configuration Management of Multiple Inputs
Another example project deals with coordinating the activities of our personnel with the work and activities of other organizations. *CTC* personnel are responsible for validating that candidate specifications and emerging R&D products conform to accredited standards (IEEE, ISO, etc.). This is accomplished by running tests against the specifications and products to validate conformance.

Team members send post-test feedback to the originating organizations (Academia, Consortia, and Private Companies). CM is accomplished on the test results. Only when all stakeholders agree are these candidate products accepted in the accredited standard. When this occurs, the accrediting body provides CM.

Measures and Analysis
The new Measures and Analysis PA caused us to look hard at how we capture level of effort (labor hours) in our projects. We developed a Process Improvement Database, which collects 12 core project activities. This provides organization-wide indicators of systems development processes effectiveness. This database is linked to the company’s electronic timesheet system to provide automated collection of NSD labor data.

All NSD programs have a basic job number. Major tasks within a program are identified by subordinate job numbers. Each subordinate job number has a suffix that is based on 12 core measures in which NSD senior management is interested. As each individual completes work on a project, he or she uses the unique project number and suffix that identifies the accomplished work.

Quality Assurance
NSD Quality Assurance operates within the *CTC* ISO auditing system. The NSD QA Lead, who is also an Internal ISO Auditor or an ISO Auditor evaluates NSD programs based on approved plans, waivers, and tailoring.

We created a Maturity Database of CMMI-SE/SW assessment questions. The NSD QA Lead uses this database during audits. The NSD QA Lead can insure randomized question selection is obtained. Results are placed in an Assessment Database, which facilitates tracking of audit results over time.

***CTC*’s Approach to Institutionalizing CMMI-SE/SW**
The company-wide training for Program Managers and Project Managers is based on the Program Management Institute’s Body of Knowledge (PMBOK™), the *CTC* ISO 9001/140001 Quality Policy, Procedures, and Work Instructions. Training for the new model required change management.
Early on, we recognized that a different approach was needed to inculcate the processes and practices of the model into our daily operations. Our previous SW-CMM transition training

emphasized the vocabulary of the model. Instead, we packaged the new NSD Systems Development Policy, Standard Process and Procedures in our familiar NSD vocabulary.

The new CMMI-SE/SW PAs and their specific practices are mapped to the new documents to ensure full coverage of all the PAs. However, only the NSD Policy Statement and Standard Process documents contain direct references to the CMMI-SE/SW. No mention is made of the model in our new Procedures, Work Instructions, or Templates.

Incorporation of the CMMI-SE/SW principals within the *CTC* QMS/EMS and the PMBOK™ framework permits us to train the new systems development process rather than the model. This methodology lessens potential resistance to change, as well as keeping the staff from viewing the new processes as "an extra burden." Instead, training focuses on the *CTC* and NSD way of doing business, with the CMMI-SE/SW silently embedded in the Processes, Procedures, and Work Instructions.

SUSTAINING MOVEMENT TOWARD CMMI-SE/SW MATURITY LEVEL 3 AND BEYOND

Early in the transition to CMMI-SE/SW a briefing for Senior Management covered the modified business procedures that would be required to incorporate L2 and L3 features of the model. Numerous review levels and multiple reviews were used to insure middle and senior management buy-in to the new process and procedures:

Process Improvement Team:	Initial Reviews
SEPG Review:	Several review cycles
Mid-level Managers:	Reviews during Bi-weekly meetings
Senior Management Review:	Draft Procedure Review
General Manager Approval:	Final Approval

- The GM issues the Systems Development Policy and Standard Process.
- The Chairman of the SEPG is the approval authority for the NSD Systems Development Procedures.
- Senior Managers, Program Managers, and Project Managers participate in bi-weekly meetings, which serve as a vehicle for discussions and feedback.
- The team develops NSD Systems Development Process Overview briefing, Procedures training, and Project Plan training.
- Transition team members serve as mentors to specific programs to ensure continuity in assistance.

While only applicable to NSD projects, the policy, process, procedures and supporting documents are available to the entire company workforce on the Intranet and can be used by any project.

Summary

This paper provides an overview of *CTC*'s approach to transition to the CMMI-SE/SW. We recognize that the transition will continue to be a challenging and dynamic process given the diversity of projects addressed by *CTC*. The NSD's continuing pursuit of process improvement is a further endorsement of *CTC*'s commitment to achieving total client satisfaction.

Efficiency in CMMI-Based SCAMPI Assessments

Rick Hefner and Ron Ulrich
TRW
12011 Sunset Hills Road
MS: VAR1/12D28
Reston, VA 20190-3285
703-345-7661, ron.ulrich@trw.com
310-812-7290, rick.hefner@trw.com

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Introduction

Although some of the assessment teams in the CMMI pilots have experienced long workdays, such days are not integral to the CMMI-based SCAMPI method. Long days have become typical of CMM-based assessments, including CBA and EIA 731. SCAMPI assessments have followed this pattern. On the other hand, many assessment team leaders have led assessments with very reasonable length days.

At TRW, we have found that long days are the result of poor implementation of the assessment methods, and not inherent in the methods themselves. Maintaining a reasonable assessment workday relies on several factors:

- Identifying an appropriate number of days for the assessment, based on the scope of the model and organization;
- Effective team dynamics, experience, and CMM/CMMI knowledge;
- Effectively using questionnaire data and document review to focus the interviews;
- Continual team emphasis on working efficiently, especially in data consolidation and findings development.

Assessments often suffer from four problems:

- The team ignores the questionnaire responses;
- The assessed organization supplies poor quality evidence material;
- The team spends excessive time drafting "perfect" words for the findings;
- The team spends excessive time arguing about issues unrelated to the final results.

TRW experience indicates that typical assessment times could be shortened by 25%-50% by effectively using the principles discussed in this paper to eliminate the scrap and re-work inherent in some assessments. This has been our experience in TRW CBA IPI assessments, where the typical assessment day does not exceed ten hours, the assessment is typically completed in 1-2 weeks, and the findings are detailed and accurate. With the improvements in SCAMPI over CBA IPI, (e.g, changing the questionnaire and collaboration rules to reduce assessment time), it should be possible to do cost-effective assessments.

Discussion

TRW has used the following mechanisms to reduce cost and time of assessments, while retaining high accuracy and repeatability:

- **Use the questionnaire responses to focus the team.**
  Use an expanded questionnaire (like EIA 731 and SCAMPI) that goes to the practices level. Give the organization a few weeks to understand and complete the questionnaire. Identify evidence in the questionnaire. Use the interviews and document review to confirm the questionnaire responses.
- **Poor quality evidence can be improved.**
  Another use of the expanded questionnaire can be to monitor the progress of projects to ensure that they are making progress in the proper identification of evidence. TRW ensures that the projects understand what they are doing to support the assessment by monthly reviews. This method also simplifies the process of documentation review for the KPA mini-teams. Using this approach usually diminishes the need for documentation requests and almost always shortens the need for multiple days of documentation reviews.
- **Don't write "random" observations, simply rate each practice.**
  "Practice is satisfied through ___" or "Practice is not satisfied because _____". Trust the KPA mini-teams to compile preliminary findings. During the on-site team training generate example findings to guide the mini-teams. Use standard phrases related to practice satisfaction. Review and wordsmith findings as a team.

Other Efficient Practices

The following additional practices should be considered:

- **Don't use a formal assessment when an informal assessment is more appropriate.**
  Unless a rating is required you should consider performing an informal assessment. Not only is this less of an impact on the organization but it also is far less costly. When performed like a CAF compliant/ SCAMPI/ or ARC it should provide sufficient findings to provide the organization with guidance for the generation of a process improvement plan. It will also provide the projects' and organizational interviewees some experience in the assessment process.

- **Don't schedule long days!**
  Plan to perform the assessment like it is a project. Don't schedule it so you have no chance to recover. Work both efficiently and effectively and the team will strive to make the days productive. If you plan on "long" days the team will not feel any constraints to achieve the goals in a normal (8:00 AM to 6:00 PM) day. The only possible long day should be Wednesday when you will generate the Draft Findings but that should be the only one.

- **Start with an overview of the organization's process and documentation.**
  Most of the team members need an introduction to the organization and to the programs. Have the SEPG prepare a site briefing that follows a template with the basic material requested in the "process appraisal information" – e.g., organization and project questionnaires, project and organization charts. They should also brief a description of the organization's processes and process structure. This further supports enabling the assessment team to enter into the interviews with a crisp understanding of the organization being assessed.

- **Have the organization compile all of the evidence ahead of time.**
  As stated above have the projects generate their answers to the expanded questionnaire and gather those artifacts. These artifacts can be placed into folders (in CMMI Process Area and practice order) for the assessment.

- **Don't review documents until <u>after</u> the interviews.**
  By having the site briefing and descriptions of the projects and organization it is reasonably easy to enter into the interviews. With only a minimal review of the evidence materials performed by the KPA mini-teams questions can be formulated to evaluate the interviewees on the performance of the activities required by SCAMPI. Once the interviews are completed it should be easy to validate any discrepancies each day (or after an interview session) to see if any follow up interviews are needed. This also facilitates generation of initial findings to maximize the effectiveness of the team.

- **Don't use more that 50% inexperienced team members.**
  Experience is the single biggest factor in the efficiency of doing assessments. We strike a balance between the need to train new assessors, and efficiency. By limited new assessors to one per mini-team, experienced team members can provide the mentoring needed to support both efficient and effective team activities. If you have an imbalance, the Lead Assessor or one of the more experienced team members must ensure the teams get the proper support needed to learn the process and to generate good findings. In addition you should always designate and train at least one alternate, who can take the place of a team member who is unable to participate at the last minute due to health or personal emergency.

- **Use tools to gather questionnaire data and consolidate/review findings.**
  Tools can especially be useful in analyzing and summarizing the expanded questionnaire, and can be used by the organization to prepare for the assessment.

Conclusions

The TRW assessment practices provide an opportunity for other assessment teams to improve their processes. Essentially, we believe the assessment community should apply the CMM principles to assessments: disciplined adherence to reasonable plans and continuous improvement.

Integrating Process Maturity Review into Project Management Reviews

SuZ Garcia, US Deployments Manager, aimware Inc.
Position Paper for CMMI Transition Workshop

Introduction

Organizations have been using Capability Maturity Models (CMMs)® as a means of improving their organizational and project management practices for several years, with significant positive results achieved in many organizations, especially in the software development area, where the models were first introduced in 1991. As far back as 1994 (Bate et al, 1994) "generic practices" for process management have been proposed that provide an evolutionary set of steps to take in improving an individual process, for example, the risk management process or the management review process. Each evolutionary step is called a "level", and the framework groups the generic practices into 6 levels, from "not practiced" (Level 0) through "optimizing" (Level 5). As the project's or organization's practices are identified as being consistent with those at each level, the process is said to become more capable, indicating that that process is more likely than one at a lower capability level of achieving stated process and product objectives, although factors other than capability are acknowledged to affect actual process performance. The most recent published expression of these practices is the CMM Integration Framework 1.02 (SEI 2000)

One potential use of these practices is as a project management checklist that can be applied in reviews and other project oversight activities to help understand how project management practices are evolving during the course of a project, and to set targets for the practices that will be performed on that or a future project. In addition, information from the reviews can help project managers understand when an organization is NOT ready for additional practices, due to foundational elements identified as being missing.

For example, at Capability Level 2, the "Managed" level, the generic practices include such items as " Provide adequate resources for performing the planned process, developing the work products and providing the services for the process," (GP2.3) and " Place designated work products of the organizational process focus process under appropriate levels of configuration management. ." (GP 2.6) At Capability Level 3, the practices evolve to include treating the process performed on the project as an organizational asset.

The sections below provide an analysis of selected generic practices in terms of their utility for use in reviewing a project that is underway, and provides rationale for the selection and use of the checklist during project management reviews.

The context of project management reviews…

In my experience acting either as a project manager or as a project participant, project management reviews have been focused primarily on the accomplishments and challenges directly related to the evolution of the project's work products from one state to the next. In this regard I'm speaking of the types of project management reviews that tend to signal the transition of a project from one major life cycle phase to another. Specifically, reviews such as a System Requirements Review, Preliminary or Critical Design Review, and Test Readiness Reviews are examples of the types of reviews that are the intended focus of this paper. Although this focus on product evolution is necessary to determine the effect of decisions being made about the project's next set of steps, I would argue that project management reviews, by virtue of their ability to bring the stakeholders of the project into the same room (either physically or, in today's environment, virtually), provide an often-missed opportunity to review and influence the work and management processes that are being used to move the project forward.

The context of process maturity reviews/appraisals…

Many organizations use formal, periodic (not synchronized with projects, usually) appraisals of process maturity to gain confidence that their process improvement efforts are bearing fruit. These appraisals can range from very informal discussions, to questionnaire-based surveys (Whitney, 1994) to more rigorous and intense appraisal methods that involve interviews of multiple levels of management and documentation reviews (Masters et al, 1996). These appraisals typically involve multiple projects within an organization or business unit. Although they provide synthesized data about the tendencies in performance of various practices on projects, generally they do not provide specific information about particular practices that have been seen or not seen in one of the surveyed projects. This confidentiality is intended to encourage project team members to honestly disclose the practices or lack thereof that are present on the projects of interest. It is believed that disclosing the exact practices of each project to other members (especially senior management) of the organization could lead to punitive actions if a project is not meeting the expectations of the organization. In cultures who are just beginning their improvement efforts, or who have very high expectations and insufficient resources to improve the project's practices, there is a decided risk related to revealing information specific to an individual project.

However, I have also encountered more than a few organizations for whom the use of such data would not be punitive; rather, it would be to help improve the performance of that project in its current state or to improve projects that directly follow from it. For these organizations, traditional viewpoints of confidentiality of project data from a process maturity appraisal are less useful, and even can be perceived by project managers and participants as a barrier to helping them improve their local practices.

What are the concepts of CMMs that are relevant to project management review?

As part of the Software CMM v1.1 author team, I was struck at how easily the topics in the CMM generally fit into one of three categories: technical, project support, or organizational support. We categorized the Key Process Areas (major topics) of the SW-CMM according to these categories, and when we abstracted the process management concepts embedded in the SW-CMM into a set of "generic" practices that were used to seed the ISO 15504 standards effort (called the SPICE project at the time) and the Systems Engineering CMM, the categorization of practices into these three areas was very helpful to the team in understanding the evolution of behaviors that a CMM was intended to support. To help understand the application of the individual practices to project management, it is helpful to understand the intent of each capability level. I tend to frame the general concepts of each level in terms of different types of learning that is being encouraged in the organization using the practices. The following paragraphs summarize my perspective on how the different capability levels reflect changes in the depth and breadth of learning going on in the organization.

There is only one generic practice at Capability Level One, which basically says that the practices in the specific topic areas of the model, the Process Areas, are performed. This provides a basis for improving the fundamental practices related to a specific topic. The practices of Capability Level 2, the Managed Level, focus on behaviors that turn *implicit* knowledge about how the process is performed and managed to *explicit* knowledge about how the process is performed and managed. I call this the transition from "individual learning" to "local learning". Knowledge that used to be in the heads of project members is now accessible to other members of the local work group or project via recorded procedures, templates, and other descriptions of the practices and the results of the project using them.

The evolution to Capability Level 3, the Defined level, involves the transition from "local learning" into "organizational learning". Knowledge that was previously only readily available to the local project team members is now communicated throughout the organization via agreed-upon process description approaches. Infrastructure (such as defined training and skill building events) that is organizational in nature is available and used to encourage the qualitative analysis and evolution of the practices. Tying project practices explicitly to organizational standards is an accepted approach to gaining knowledge about the variations in project practices across the organization.

The evolution to Capability Level 4, the Quantitatively Managed level, involves the transition from "organizational learning" to "quantitative learning". This is not meant to imply that measurement is not used at lower levels to gain insight into the performance of project or organizational processes. However, at levels prior to this, the expectation that measurement and quantitative data are a primary support to project and process decision making is not yet emphasized. One of the frequently debated questions among authors of CMMs is whether or not all processes used to support product development are amenable to evolution to level 4 and whether quantitative insight is necessary for all processes to be optimally effective. Certainly a significant subset of product development and management processes would be deemed worthy of this investment in organizations that are seriously pursuing widespread process improvement.

The evolution to Capability Level 5, the Optimizing level (note the change in language for this level's title. It is intentional. The idea of Level 5 is the optimization process is a continual one that does not end just because the definition of the model has ended), involves the transition from "quantitative learning" to "complex learning". When I use the term complex here, I'm using it in the context of complexity and chaos theories that are starting to be applied to the management environment (Stacey, 1996). These theories argue that complex adaptive learning is the hallmark of an agile, flexible organization that is capable of responding to rapidly changing internal and external stimuli. The intent of Optimizing practices is to encourage the behaviors that would likely lead to the kind of agility described by management theorists applying complexity concepts to organizations. It is my view that the first four capability levels tend to focus on "operational" process management, while the fifth level switches the focus to "strategic" process management. Although a set of practices has been written (and rewritten, and rewritten!) to support this intent, this level is the most difficult to describe in terms of behaviors reflected as practices.

How can CMMs be used to help projects improve their practices directly?

The following graphic has been used to notionally describe some of the evolution concepts discussed above related to CMMs (Garcia, 1996).

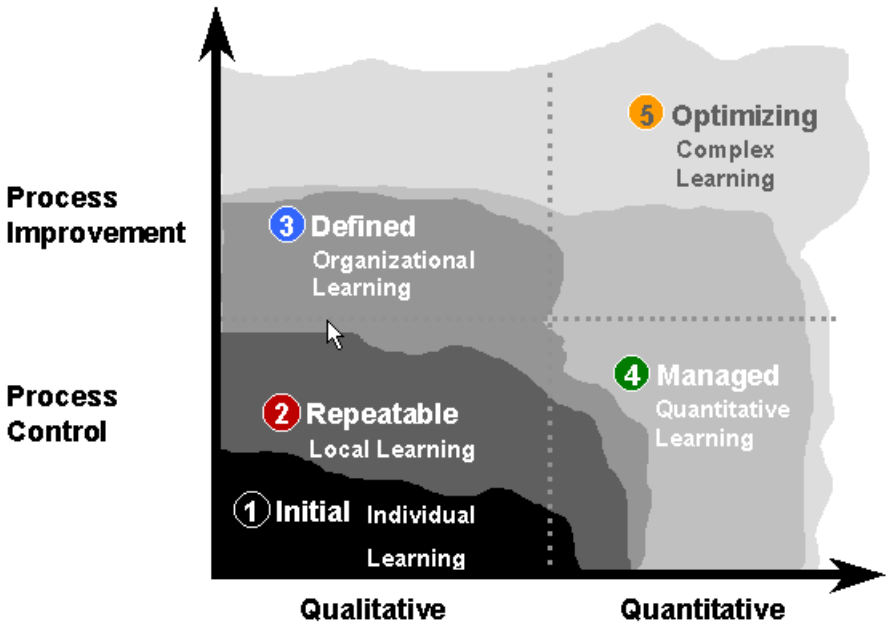

Exhibit A. Notional view of Evolving Capability along Different Dimensions

Notice that the figure looks at two dimensions to describe the evolution of capability in an organization: the evolution from qualitative to quantitative, and the evolution from control to improvement. If you think about improving project management practices by paying attention to process maturity, these two dimensions of evolution, combined with the learning concepts discussed in the previous section, combine to provide a powerful framework for analyzing and improving project practices.

Operationally, the generic practices at Capability Level 2 are all focused on and targeted towards organizational practices; there are additional project-focused practices at Levels 3, 4, and 5 that build on this initial set. Transforming the generic practices targeted to project issues into a set of project management review questions is a simple yet powerful way to help focus the project's management and participants on paying attention to the evolution of their process at the same time they are paying attention to the evolution of their products.

Exhibit B is a table that transforms the CMMI 1.02's project-focused Capability Level 2 generic practices into a set of review questions to be incorporated into the agenda of project management. I suggest using a scale of 1 (practice rarely seen on this project) to 5 (practice is always performed on this project) as a "self-rating" method for the processes that are of interest to the project, particularly the management processes. A different rating table can be used for each process of interest (for instance, there may be significant differences in how many of these practices are exhibited within the Project Planning process vs. the Data Management process). Some of the questions are direct inversions of the practice into a question. Others separate the practice into two separate questions, where my experience indicates that there is often a different set of behaviors going on related to the different parts of a practice. Whenever you see "the process", you would want to substitute the actual process of interest for the general term (e.g. "the project planning process").

Generic Practice Number	**Generic Practice Text**	**Related Review Question(s)**
GP 2.2	Establish and maintain the requirements and objectives, and plans for performing the process.	To what extent was the use of this process for this project planned? How often are the plans for performing the process updated? (not a 1-5 question)
GP 2.3	Provide adequate resources for performing the planned process, developing the work products and providing the services for the process.	To what extent are resources explicitly allocated for performing the process and developing its work products? To what extent are the resources allocated for performing the process considered adequate?
GP 2.4	Assign responsibility and authority for performing the process, developing the work products, and providing the services of the process.	Are responsibility and authority for developing the work products and providing the services of the process assigned?
GP 2.5	Train the people performing or supporting the process as needed.	To what extent are individuals performing the process appropriately trained to support their performance of the process?
GP 2.6	Place designated work products of the process under appropriate levels of configuration management.	Are work products important to performing the process identified? Are identified work products of the process placed under version or configuration control?
GP 2.7	Identify and involve the relevant stakeholders of the process as planned.	To what extent are the relevant stakeholders for this process identified? To what extent are the relevant stakeholders for

		this process involved?
GP 2.8	Monitor and control the process against the plan and take appropriate corrective action.	At what intervals is information about the progress of this process within the project tracked and made available? (not a 1-5 question) To what extent is appropriate action taken when significant deviations to the plan for this process are identified?
GP 2.9	Objectively evaluate adherence of the process and the work products and services of the process to the applicable requirements, objectives, and standards, and address noncompliance.	Are work products verified against applicable requirements? (these could include both product and process requirements) To what extent are identified noncompliance issues addressed?
GP 2.10	Review the activities, status, and results of the process with management and resolve issues.	To what extent is the status of the process reviewed with management? (this one should be a "gimme" if you're implementing this project management review approach!!!)

Exhibit B. Table of project-focused Capability Level 2 Generic Practices from CMMI 1.02

Since CMMs are additive in terms of the expectations of the practices being performed, you may find it useful to restrict your initial set of questions to ones like those in the table, without regard (initially) to higher maturity practices. Once at least half of the questions would be at least at a 3 on your sliding scale (practices are performed frequently) you may want to add the level 3 practices that relate well to project management reviews.

This initial set of "translated" practices is only a starting point for projects that wish to have insight into the evolution of their project's management practices using a CMM. Within CMMI 1.02's description of generic practices an elaboration statement is presented that provides information about how that generic practice might be applied to an individual process area. Especially for organizations that look at one of these practices and ask "What is the scope of this generic practice?", the elaborations provide some suggestion of the types of activities that would be expected for an individual process to demonstrate use of the generic practices.

How would project management reviews change if process maturity were included?

When I think back to some of the more challenging product developments I have been involved with, I wonder about the effects that using these questions or a subset of these questions would have had on our management's focus regarding the project's processes and products. How surprised would they have been when the answer to one or more of these questions didn't meet their expectations? How would they have reacted? I know some of them would have put some serious effort into correcting process problems that would be likely to add project risk….I don't know a single project manager who would investigate why work products were "not often" put under version control, for example! I suspect the best of the project managers I've worked with already had a mental "process checklist" that they may have used to do their private risk analyses on the project. As more projects start looking into these areas, I look forward to future papers providing insight into risk reduction and improvements in practices and products that result from this expanded focus for a project management review.

Summary

This paper has presented a use for generic practices of CMMI 1.02 that suggests that they can be adapted into sets of questions that can open up the context of project management reviews to include local process maturity review. CMMI 1.02 contains practices that are specifically geared toward the project context, and this fact provides a framework for systematically gathering data about the extent

of the use of practices that can improve project repeatability and consistency. Project managers and practitioners who adopt this approach are encouraged to share their results with the project management and CMM communities to help evolve the understanding of the appropriateness of this usage of generic practices.

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TACOM-ARDEC WHITE PAPER

SUBJECT: The Road to CMMI: What Works, What's Needed?

PURPOSE: Describe mechanisms the US Army TACOM-ARDEC LCSEC and STAR organizations developed to implement CMMI and summarize the experiences resulting from transition to CMMI.

ORGANIZATIONAL ENVIRONMENT FOR PROCESS IMPROVEMENT: The process improvement activity described in this paper involves two related software support organizations located at TACOM-ARDEC, Picatinny Arsenal, NJ. These two organizations were separately implementing process improvement programs. To implement CMMI, these two organizations merged their strategic improvement objectives and conceived a unified organizational strategy that would speed their process improvements and address full implementation of the emerging CMMI.

TACOM Life Cycle Software Engineering Center (LCSEC). Provides software development, software configuration management, and post deployment maintenance support for DOD weapon systems and training devices. Provides software engineering and acquisition support to Program Managers (PMs) during system acquisition.

QED System/Software Technology, Analysis and Reliability (STAR) Team. Performs software and system quality assurance functions. Develops nondestructive test technology and measurement technology. Focuses on quality analysis and reliability for propellants, explosives, fire control, pyrotechnics, tools and equipment.

The combined organizations have 166 personnel (91 Government, 75 contractor) that perform primarily software engineering and support tasks. The product areas supported by both organizations include Artillery, Munitions, Trainers, and Combat Vehicles.

USEFUL MECHANISMS:

1. Unified Transition Strategy. The unified strategy created by the LCSEC/STAR organizations was focused on the smooth transition from existing processes to a unified, integrated CMMI implementation.

Designed, developed and implemented a set of common, standard processes (Common Policies and Common Procedures) that track to the evolution from the SW-CMM, SA-CMM, and SE-CMM to CMMI. Revised and expanded the scope and methodology of the existing policies to address the requirements of CMMI. Developed traceability matrices (CMMs/CMMI - Standard Processes) and performed a Gap Analysis to ensure that all CMMI practices were addressed. Ensured that the set of policies and procedures were jointly implemented in both organizations.

Included available, on-site subject-matter experts in the planning and implementation efforts. Integrated CMMI development and assessment knowledge into assessment training and preparation activities. On-site availability of knowledgeable experts enabled additional insight and expert input into the development and acceptability of processes, training, coaching and planning.

Issues addressed: Inertia and cultural resistance to changes in scope, practices and implementation methodology that would be expected from changing to a different CMM were neutralized by this evolutionary transition approach.

Aids to CMMI implementation: Created and implemented a set of standard processes (Common Policies and Common Procedures) that track to CMMI practices. Based all training and coaching efforts on this set of policies and CMMI practices.

Benefits derived: Positioned the organizations to participate in a CMMI pilot assessment, with those attendant benefits. Avoided rework and non-productive efforts expected from continuing to implement separate programs and processes.

Dissemination: Posted the set of standard processes and supporting documents on the Process Asset Library (PAL). Defined the strategy in a unified Capstone document. Briefed the strategy to upper-level management and all organizational personnel.

2. Organizational Issues: The unified strategy facilitated the common application of resources for joint projects and accelerated the institutionalization of the standard processes by both organizations. This unified application also enabled the adoption and adaptation of CMMI to non-developmental projects.

Adopted and implemented the Software Enterprise concept, based on a set of common processes, modeled on CMMI. Capitalized on the two organization's complimentary missions and functions. Addressed supporting participation in joint projects. Designed a common senior management review activity. Combined the Process Engineering Groups (PEG) from each organization into a single, unified PEG. Improved our ability to work together; synergized and accelerated the improvement process.

Integrated the Quality Assurance (Process Assurance and Product Evaluation) function across both organizations. Applied CMMI (vice the SW-CMM) to foster a better, more unified definition and implementation of the quality assurance functions; improved the communication and cooperation between the organizations; and eased the integration of the unified partnership.

Applied CMMI to non-development projects (e.g., service, IV&V, test). Using CMMI permitted the application of the standard processes to all LCSEC and STAR projects, which increased and broadened the scope of management insight. Including all projects provided added insights into the tailored application of CMMI.

Issues addressed: Definition of a mutual and supporting approach. Adjusting the two improvement programs to support common objectives. Commonality and unity of purpose. Coverage of service related projects.

Aids to CMMI implementation: Unified Capstone document that established and communicated the organizational objectives. Lessons learned and experience gained from a previous pilot assessment of CMMI by STAR, and a dry run of CMMI by LCSEC.

Benefits derived: Better use of project resources. Application to all projects. Mutual standards and evaluations.

Dissemination: Publication of the Capstone document. Briefings by Senior Management, the unified PEG and the unified QA Project to all personnel.

3. Management Commitment and Communications: Combined resources and strategic commitments from both organizations focused upper-level management attention on the CMMI program. Capitalized on the achievements of similar Army organizations to foster motivation and commitment from senior and upper-level management.

Exploited previous difficulties as individual organizations. Used deficiencies uncovered by the previous assessment and dry run to provide the precept and impetus for renewed, accelerated and unified improvement efforts.

Used successes experienced by sister organizations. When other Army software support organizations publicized their SW-CMM successes, this publicity energized senior management to expand their vision for the TACOM-ARDEC software community; enabled the upper-level management sponsorship and support that was critical for accelerated implementation of CMMI.

Obtained commitment of management to active and frequent participation and involvement. The senior managers initiated and implemented weekly senior management meetings to specifically address the status and progress of the unified process improvement program. The TACOM-ARDEC upper-level management also instituted a set of special in process reviews (IPRs) to address progress toward achievement of CMMI Levels 2 - 4. These added initiatives served to emphasize to all personnel the importance placed by management on the unified program and improve the response and support from the LCSEC and STAR personnel.

Developed a unified PEG workshop methodology, expanded membership activity and implemented a unified improvement schedule. Established a regular twice-monthly PEG meeting schedule. Designed the membership to include the active participation of the senior managers and project leaders as PEG members. Used this forum to both communicate requirements/status, and to obtain periodic feedback, consensus and buy-in.

Issues addressed: Sponsorship and support from management. Communication of unity of purpose and commitment to all organizational personnel. Active involvement and buy-in from all levels of management.

Aids to CMMI implementation: PEG schedule and corrective action plan, mapped to CMMI practices, that addressed the results of the previous pilot and dry run. Status briefings and PEG reports that addressed the status of CMMI implementation.

Benefits derived: Improved communication, feedback and buy-in by all levels of the organization.

Dissemination: The PEG Workshop Proceedings posted and e-mailed to all members. Results of upper-level management briefings provided to all personnel.

4. Artifacts and Tools: Modified existing tools and artifacts from each organization to address the practices of CMMI, then transitioned and made them available for both organizations. Applied the resources of both organizations to the identification and development of added framework elements and artifacts to address CMMI.

Established combined Process Asset Libraries (PAL) and data repositories. Developed a set of web pages and repositories for storage and access to process improvement information. Made this information readily available to all LCSEC and STAR personnel. Expanded the use to both organizations of the existing CM Repository for storage and control of both project and baseline information. Also expanded and adopted an existing DM Repository for electronic storage and ready access of project work products.

Developed additional framework elements and implementation aids. Developed a set of procedures (organizational and project), standards, templates, checklists, forms, briefing slides, and guides for use by the project personnel. These added framework elements provided an added commonality and standardization to the work product development and management activities.

Identified and collected standards and examples of work products and artifacts. Expanded on the information contained in CMMI practices to provide added guidance for development and maintenance of artifacts. Identified examples of acceptable artifacts and incorporated them into the PAL. Identified specialized work products required by unique ARDEC support infrastructure (Training, Procurement, Materiel Release) and incorporated examples into the PAL.

Integrated the Quality Assurance audit process with CMMI requirements and practices. Established a unified QA Project and a set of checklists that audited compliance with the set of organizational processes and provided traceability to CMMI. Provided independent input as to the state of project implementation of CMMI; provided early warning of areas needing improvement, and monitored the corrective action plans.

Issues addressed: Common documentation structures. Acceptable quality of artifacts and project records. Standard application and use of tools.

Aids to CMMI implementation: Common PAL, which provided organized access to process elements (both standard and tailored). The set of audit checklists that provided traceability to CMMI.

Benefits derived: Common training and coaching base. Uniform assessment of standards compliance and work product usage.

Dissemination: PAL, CM Repository and DM Repository. QA Project Audit Reports.

5. Training Initiatives: Used personnel trained in CMMI and on-site subject matter experts to develop and implement CMMI training tailored to the organization. By using these resources, completed a series of training and coaching sessions in much less time and with minimal coordination.

Created a set of questions and answers that address CMMI practices. Developed different shreds of CMMI that track to the various organizational and project roles in the LCSEC and STAR organizations. Used these to help the personnel understand the requirements for and meaning of CMMI.

Accomplished a pilot assessment of the draft CMMI (STAR) and an internal dry run (LCSEC). Built on joint commitment to implement CMMI, and the assessment and dry run, to secure senior management sponsorship to par-

ticipate in a CMMI V1.02d pilot assessment. Exploited SEI participation. Implemented corrective actions identified by the previous pilot and dry run, to accelerate our process improvement, as measured against CMMI.

Designed a specially targeted training and coaching program. Designed and implemented a set of training sessions, training aids, and coaching sessions that were specifically targeted to improving the knowledge and understanding of CMMI requirements and practices, as implemented in the set of policies and procedures. Trained and used the set of policies and procedures as the basis for the process improvement efforts.

Acquired additional CMMI Training. Arranged for CMMI training courses targeted to the organization. This training, arranged for and supported by our on-site subject matter experts, enabled an accelerated understanding and application of CMMI requirements and practices.

Issues addressed: Familiarity and understanding of CMMI practices by all personnel. Identification of areas needing extra management attention and emphasis.

Aids to CMMI implementation: On-site expertise and training. Training slides and courses that addressed CMMI and the unified process framework.

Benefits derived: Accelerated level of understanding and knowledgeable application of CMMI. Able to focus resources on improving weak areas.

Dissemination: On-site training courses. Posted training information and material in the PAL.

SUMMARY:

Lessons Learned:

1. Active senior management involvement is prerequisite. Periodic meetings must be established to maintain this active participation.

2. Communication, training and coaching are all essential and must be integrated.

3. CMMI and the standard processes must be supplemented by an extension of the framework to include templates, forms, and checklists for use by the projects.

4. The membership of the PEG needs to be expanded to include all of the project leaders.

5. CMMI does not address the quality of the framework, all of the activities or all of the work products. The organization, and the PEG especially, needs to be constantly sensitive to the quality of the implementation.

6. CMMI needs to be tailored for application to non-developmental projects.

7. A central PAL and repository are basic and must be actively stocked and maintained.

Successful Practices:

1. Active integration of the quality assurance function into the process improvement effort, especially targeting the audits to assess compliance with CMMI as reflected in the standard processes.

2. Extension of the standard processes through a comprehensive set of framework elements, such as templates, forms, checklists and training information.

Transition-related Benefits:

1. CMMI is less burdensome in the implementation phases. For example, the extensive set of specific documented procedures required by SW-CMM have been eliminated, permitting a more tailored, economic development of the standard processes and procedures.

2. CMMI provides detailed integrated acquisition management coverage that was only partially available in the SW-CMM.

3. Ability to apply CMMI to non-developmental projects increases “bang for the buck”.

Authors:

Wayne Sherer, TACOM-ARDEC FC & SED, Senior Technical Associate for Corporate Process Improvement

Mary Gregg, TACOM-ARDEC LCSEC, PEG Leader

Chuck Gordon, Anchor Software Management, PEG Facilitator

Alison Ferraro, TACOM-ARDEC QED STAR, PEG Leader

Working Group 1.5 – CMMI[SM]

This white paper was contributed by Working Group 1.5 during the High Maturity Workshop held at the SEI March 27–29, 2001. Participants included:

Julie Barnard	United Space Alliance
Bruce Boyd	The Boeing Company
Lynn Carter	SEI
Mary Beth Chrissis	SEI
SuZ Garcia	SEI
Diane Gibson	SEI
Vivek Govilkar	iFlex Solutions
Craig Hollenbach	Litton PRC
Mike Konrad	SEI
Gerry Ourada	Lockheed Martin
Lynn Penn	Lockheed Martin
Lita Schulte	The Boeing Company
Raj Shekher	Mastek
Ashok Sontakke	Zensar Technologies
Albert Soule	SEI

The facilitator was Mike Konrad. The scribe was Lynn Penn. The recorder was Diane Gibson. Julie Barnard and Bruce Boyd volunteered to be the report editors. Julie Barnard presented the working group's findings to the workshop. Note that there were two separate working groups on the CMMI[SM] topic at the workshop, due to the level of interest in the topic expressed by the workshop attendees. This CMMI[SM] working group (1.5) was the first of the two working groups convened on the topic. Different participants were involved in each of the two CMMI[SM] working groups.

Hypotheses and Observations

This section discusses the observations, hypotheses, and propositions that initiated the discussion. Also included are the results of brainstorming activities that did not become a working group consensus.

The working group brainstormed the following set of initial questions to be discussed:

- How does an existing high maturity software organization integrate with a relatively immature systems engineering organization when transitioning from Software CMM® to CMMI?
- What is the next step for CMMI[SM] development and release? How do we plan for CMMI[SM] over the next two years?

- How will CMMI[SM] help organizations that develop custom software? How will CMMI, which covers systems engineering, help those who don't see systems engineering as part of their business? How practical are CMMI[SM] assessments if they can take 2-3 weeks?
- Where can we find mapping from Software CMM® to CMMI[SM] for higher maturity level organizations?
- What are the qualifications for SCAMPI assessors? How long do assessments take?
- How do you integrate a number of separate legacy organizations using CMMI[SM] following mergers? How difficult is it to cover a diverse organization with a common CMMI[SM] assessment?
- The CMMI[SM] product development team is interested in hearing the concerns of industry on the model. How do you apply CMMI[SM] to commercial products not currently covered by CMMI?
- When merging various companies into one, shouldn't we deal with the merger issues first, then CMMI? Software is just a part of what the company does – CMMI[SM] will cause companies to pull in more of the organization than just engineering into their improvement plans – for example, things in the factory, or in the quality side of the house. We're implementing Level 4 in software for commercial production because we know it is the only way to meet the contract. We would like to do similar improvement on the engineering side of the house.
- We are currently Level 5 with both Software CMM® and Systems Engineering CMM®. We are currently in the rollout and integration of CMMI[SM]. We were also member of the CMMI[SM] working group previously. We want to see how CMMI[SM] has evolved and get results from the pilot assessments. We'd also like to hear interpretations of the continuous vs. staged representations.
- SEI would like to understand what high maturity organizations think about the practices at Levels 4 and 5 in CMMI[SM] version 1.01. How different are they from Version 1.1 of Software CMM®? How much is enough to be assessed at Levels 4 and 5? How much of the product life cycle needs to be brought under statistical process control?
- We have a similar question regarding Technology Change Management -- When high maturity organizations evaluate and decide to adopt new technology, is that activity supposed to be under Statistical Process Control (SPC)? Since technology is changing quickly and changes are happening so fast, should it be [under SPC]?
- What are the lessons learned that could be used by a novice organization applying CMMI[SM] vs. an organization experienced with Software CMM®?
- Where is CMMI[SM] going in the future? Will it include the People CMM? Will it apply to an Information Technology organization? Will there be one assessment for entire organization?
- What experiences have people had with CMMI[SM] lessons learned? What about extending the CMM® to other areas?
- How do you perform Statistical Process Control for areas other than software specific development?

Several working group members asked for background information on CMMI[SM]. Mike Konrad (SEI) provided a brief summary of relevant CMMI[SM] information to the group. Since this

information is readily available from the SEI website and other sources, it is not reproduced in this report. Some of the members asked about mapping of various other models and standards to CMMI[SM]. It was noted that some useful mappings are available on the Software Technology Support Center (STSC) website http://www.stsc.hill.af.mil/. Additionally, the SEI web site includes pointers to the same mapping documents resident on the STSC web site that compare the Software CMM® to the CMMI[SM] and vice-versa.

During initiation of the working group, the working group members posed the following questions or observations:

Observation #1: Are software organizations using CMMI?
It was argued that software engineering and system engineering are not really separate disciplines -- either or both have been characterized as encompassing the other. Engineering process areas talk about defining the processes that go with developing and using the product: manufacturing, customization, training, repair, etc. A broader view of life cycle is required – for example, maintainers of products who know all the effort required to make a product useful and keep it functional. CMMI[SM] gives more attention to these stages. Organizations that are only developing software still have integration issues about installation, help desk, tech support, etc. CMMI[SM] gives software organizations that develop applications a model to include other aspects of product development; e.g., relevant stakeholders. CMMI[SM] practices integrate more decision-making and parts of product development. The value of SW-CMM® was to give focus to neglected areas such as support and project management. CMMI[SM] folds in lessons learned from SW-CMM® and from engineering – EIA 731. CMMI[SM] tried to capture these lessons learned. At Software CMM® Maturity Levels 4 and 5 one of the lessons learned was that the Technology Change Management and Process Change Management Key Process Areas could be merged (from the workshop on TCM); also, product lines were included in SW-CMM® Version 2. There is still an opportunity to look upstream, downstream and laterally for information about the products and services an organization provides.

The issue that the working group discussed in more detail was:

Marketing

- Commercial organizations have different issues from defense contractors; for example, marketing is so much more important. Does CMMI[SM] focus more on marketing, or might it?
- System engineering issues – customer requirements, product management, etc. -- often focus on information needed by marketing. Someone is working on a Masters thesis on a CMM® for marketing.
- Does the model sub-optimize the commercial, marketing approach?
- CMU is working with private, commercial companies – using the CMM® as a focal point (e.g., Sun, Adobe, 3Com, Oracle).
- Look at the participants in the development of CMMI[SM] – most were defense contractors. – but there were some commercial companies – Motorola, Ericsson – all were either defense or telecommunications companies. SW-CMM® began as a tool for defense contractors with SEI shepherding the flock. SEI wants input from commercial organizations, but SW-CMM® is something for software development – marketing folks are not very excited about it. It would be better if there were something that comes from marketing to get them involved. CMMI[SM] has stakeholder involvement; i.e., coordination

with the stakeholders group; but it suffers from not having an explicit "marketing the product" process area. Maybe this will happen in the future?

- Business acquisition is a major focus of companies. Requirements are important, but also need the business acquisition process (business development, marketing) to focus on risks, etc. CMMs give a push to engineering but not to marketing.
- When we bring software or engineering improvement to the boardroom, CMM® seems parochial. They are more interested in growing the business and making profits. We need to bring software improvement back into improving the business and addressing business issues.
- People are making the argument that CMMI[SM] has to be translated for specific business contexts. If CMMI[SM] constrains ability to meet business goals, we would like to hear more examples or evidence of this.
- CMMI[SM] has weaknesses in the areas of marketing and business development. Whatever the SEI wants to address regarding marketing needs to be clearly addressed in training for instructors and for assessors. We don't expect this to really change in next 3 years.
- Is there a set of principles that can be used as guidelines in other parts of organization that are outside the CMMI? For example, are there architectural principles for adding new disciplines, or new generic practices? Is there a single model for product development processes / organizations and a path for adding other disciplines and application environments?
- We are looking to members of this group for people who are applying CMMI[SM] in the commercial world and in other areas for their insights.

Observation/ Question #2: Standard CMMI[SM] Assessment Method for Process Improvement (SCAMPI) issues

- Initial concern – SCAMPI takes such a long time and is an intense effort. Today it takes about 100 hours (clock time) over 9 days. The second time a lead assessor takes less time. It's getting more like CMM® Based Appraisal for Internal Process Improvement (CBA-IPI), plus there are some innovations that could also be used in CBA-IPI.
- Concern with CMMI[SM] – It is possible (likely?) that Dr. Etter will change the requirement for SW-CMM® Level 3 to CMMI[SM] Level 3 or something equivalent. How assessments are done is critical here.

Observation/ Question #3: CMMI[SM] changes

- CMMI[SM] Version 1.1 is expected to be released in December, and then be stabilized for four or more years. The desire is that V1.1 will be similar enough to V1.0 that folks won't need to be retrained. No changes are expected in a number of process areas; goals and practices should be pretty much the same.
- Biggest changes will be in the evaluation techniques (SCAMPI). From Dr. Etter's office – there will be a "source capability evaluation" method. We do anticipate changes in the assessment method to save time and take advantage of lessons learned in pilot assessments.
- Regarding which new disciplines will be added to the model: there is no clear direction. Will add acquisition in some form; security is pushing also; enterprise modeling, pro-

gram office, etc. are all being raised but no decision has been made. People CMM® Version 2 is being crafted to be compatible with CMMI[SM] – there have been joint assessment of People CMM® and CMMI[SM].

Observation/ Question #4: Expansion to other areas

- One company tried to include other disciplines using the SW-CMM® – but when senior management heard about CMMI[SM] they stopped that initiative. Moving improvement into product development processes, which is more than just integrated engineering processes.

Observation/ Question #5: SPC

- CMMI[SM] promotes doing SPC where the business case suggests you need SPC. If TCM is very important to an organization, then they might want to use SPC for TCM – in other organizations, this may not be needed.
- How much SPC is enough? Are there any universal processes that should always be placed under SPC?

Issue A: How will CMMI[SM] apply to a novice organization vs. one with a mature software organization? If you have several pockets of high maturity practices, how do you apply CMMI[SM] to additional areas?

Examples of high-maturity organization experiences:

- System engineers wanted to learn and adopt processes used by software folks when they participated in Integrated Product Teams (IPTs) with Level 5 software engineers.
- An executive commented that their company no longer received complaints about software, but they still got complaints about other engineering domains – so they tried to apply CMM® principles to top level product development processes, including engineering, business, and end-to-end processes. They intend to apply CMMI[SM] at some point. This was an example of executive push. Having demonstrated the benefits of CMM® in software, they wanted to apply it more broadly. It was somewhat awkward to apply CMM® outside of software, but it was a valuable exercise. There was previously no concept of peer reviews of business plans, but the practice was introduced because it made sense -- they were important documents.
- Experience getting ready for a CMMI[SM] pilot: It was recognized that SW-CMM® had added value and been beneficial to the software community, so engineering management was ready to try it, even though they didn't know exactly what it was. They saw real benefits from the Level 3 aspects, rather than the high maturity aspects.
- Another organization doesn't have mature system engineering and has software engineering communities that are diverse. There are up-front components and back-end components that haven't paid enough attention to process improvement. When SE-CMM® came out, they looked for areas to piggyback usage between software and system engineering – where they could use software processes in the system engineering world. System engineering processes became part of the improvement structure. Total

Quality Management (TQM) also provided some foundational principles that extended across disciplines – TQM was highly leveragable. Qual tech, TQM approach was applied across the organization first, then they applied SW-CMM®.

- Another organization matured in both system engineering and SW-CMM®. They replaced SEPGs with an Engineering Process Group, with members from software, system engineering, quality, configuration management, business development, process improvement, etc. They needed this joint structure to achieve joint improvement. The resulting processes are credible because they have a representative from each area in the group. When they establish processes in software, they need involvement of estimators, managers, etc. It is beneficial to put all groups together in the process group so they define processes together, and allow for a more natural progression. This was the biggest benefit: to have everyone work together. As they pulled new organizations into the company (by merger), the process group was able to deal with the mapping and the processes in the new organization.

Question: If an organization is starting from scratch (no previous CMM® experience), do you recommend first focusing on software and then including other engineering areas? Or should you go for them all concurrently?

- One organization embarked on an enterprise level improvement effort by first getting software to Level 3. They wished they had done it all together from the start. Software had a lot invested in their approach, and had to convince others that their way was good for all.

Conclusion: Depending upon the organizational circumstances there were examples described that support both positions -- software can be an inspiration for other parts of the organization, or it can be best to introduce change across the entire engineering organization at one time.

Another organization implemented ISO 9001 first, then SW-CMM®, then TQM in 1995. They included Human Resources and other areas, including marketing, into their TQM implementation. They will limit the use of CMMI[SM] while still looking at the enterprise through TQM and benchmarking.

CMMI[SM] reinforces the shared model – defining high leverage process areas for all of the organization. It highlights commonality and areas for integration.
If an organization is looking at leveraging high maturity experience to areas with no maturity, the CMMI[SM] Generic Practices (GPs) are the basic behavioral principles that can be used in any discipline. They become a model to use in every discipline.

The set of GPs is a candidate for high leverage processes for different areas. Generic practices can be used in many areas for process improvement.

Issue B: Applying CMMI[SM] to additional areas? What is the effect of organizational mergers on high process maturity?

Some examples follow of high-maturity organization experiences with acquisitions, mergers, and reorganizations and its associated effect on blending processes and process maturity:

- One large company of approximately 8500 people integrated another organization of approximately 2000 people together through a merger. In discussions on the process standard to be used for the newly formed organization of 10,000 people, the company level process group began to talk about what level of process commonality should exist across the organization. The standard process existed prior to the merger; however, it was recognized that the existing process standard might not be immediately achievable by the new parts of the organization. Representatives from the new part of the organization participated in the company process group to review the process standard. The company process standard, which is the set of minimum standard processes to be used for all organization, covers 20 processes. Each process is represented in about 1 page of structured English text and is task oriented. As a result of the merger, the process standard was modified so that the level of detail was raised for the newly formed organization to something that everyone could live with, that their supporting procedures could support, and that everyone across the organization could use the process standard. As the revised higher-level standard was adopted and deployed by the newer group, then the company process group could revisit the level of detail in the standard. The process standard began to get more detailed as more parts of the organization used similar processes. At a later point in time when a second new group was incorporated into the company, the review of the processes began again to determine what lowest common denominator of standard process could be accepted across the board. The detailed process information was captured and retained during these revision periods so that the processes could be tailored subsequently and include the details as appropriate.
- In another organization of about 2200 software people, they tried a similar approach when affected by a merger. One of their big struggles was with the customer Defense Contract Management Agents, who report to different program offices. The program offices were resisting the standardization of processes, because they are site focused. They are comfortable with the way things are and don't want to see changes. In this case, if the customer were allowed to drive the standardization, then there could be backward, instead of forward progress.

In addition to the software process impacts associated with mergers, there was discussion of impacts to areas such as Human Resources, marketing, financial practices and the importance of these issues. In one company, there was focus on workforce issues (e.g., through the People CMM) once the high level process group was established and the technical processes had achieved a high level of maturity.

In one organization, the affected groups had to evaluate their compliance to the standard process through their implementation of it. This included use of tools and detailed procedures in implementation of the standard process. For example, the configuration management process standard contained a list of required tasks. Different parts of the organization used different configuration management tools; however, as long as the tools accomplished the required tasks and roles in the high level processes, then there was no need to change tools. If the tools in use did not accomplish the required configuration management tasks, then that part of the organization needed to show how it would accomplish all of the required tasks from the standard. In some cases this resulted in a change of tool use. New projects were expected to use centrally chosen / supported tools. A similar approach was used in evaluating the compliance of low-level procedures and their support of the high level process. If part of the organization used a procedure that accomplished all the required standard tasks, then it could be maintained. Commonality was sought where it made sense. For example, different kinds of peer reviews were being practiced in the organization. To try and standardize the

inspection process, a formal kaizen event was conducted on inspections. This resulted in the same form of inspections being adopted throughout the organization.

In another organization, mapping and standards were in place across the new organization, but training and implementation were lagging behind a bit. In addition, there was some resistance to things like quantitative management. So, that part of the organization does not achieve maturity Level 4 in the targeted time period (e.g., 6 months.)
One organization divests itself of part of its group. The Level 4/5 group ended up trying to maintain their maturity level through 'tribal knowledge'. They winnowed down their documentation, but found that they did not have enough detail to adequately train new people. The veterans ("old timers") knew the process, but many of them were retiring. This caused a need to re-document their processes. They struggled through a Level 3 assessment – and are climbing back up. The documentation was not adequate to sustain Level 4 when they lost so many people who had institutionalized processes and had created a stable organization. This organization recommended that documentation be evaluated using criteria of how easily someone can pick it up and learn to do the processes.

One organization represented in the working group was about to be involved in a merger and was seeking suggestions from experienced organization for what it takes to maintain process maturity during take-over. Some ideas provided from "merger-experienced" organizations were provided:

- Be careful about how senior management describes, documents, and represents the take-over. In one case, the combining of organizations was declared to be a merger and not to be a take-over and that the best was to be combined from each of the merged organizations. However, the management of the combined organization was all from the organization that initiated the merger; which reflected the perception of take-over rather than merger. Teams need to be established as soon as possible and should begin talking before the "thou shall do…" is issued from the top management.
- In another organization, a lot of time was spent getting to know other process people in the organization to establish contacts and exchange process ideas. This resulted in not artificially forcing any combinations.
- In another instance, a Level 5 organization merged into a Level 3 organization. New people began to work with and help the Level 3 folks with their issues. They worked toward renaming processes - no one retained the old process names, but rather worked toward creating some new names that both organizations could live with and did not convey any ties to the past organizational structures.
- It was suggested to be cautious of the snob factor and not convey one organization as "better" than the other even when there are differing maturity levels. Ultimately, there should be common objectives and goals that unite the groups and the "more mature" groups should assist the "lesser mature" groups and do so in humility.
- In order to posture a high maturity company so that the impact of mergers is lessened, it was suggested that metrics be shared with new organization and new management as a part of the familiarization and transition.

Issue C: SOFTWARE CMM® and CMMI[SM] – key differences ?

One of the new process areas in CMMI[SM] is **Measurement and Analysis**. With the Software CMM®, it was believed that there wasn't enough measurement represented at lower levels. Even though measures existed for each key process area, they were often considered not to be

useful measures. For some organizations that were striving toward Level 4 maturity, they sometimes had to rethink a lot of measures that were put in place at lower level key process areas. Some organizations reported that they did not wait until maturity Levels 3 or 4 to do process measurement and quantitative management, but rather that measurement was important to establish at lower levels. The existence of Measurement and Analysis is one of the things in CMMI[SM] that may help organizations get to higher maturity levels faster by providing the necessary foundation.
Some lower maturity level organizations may not see the need for metrics because they are so busy just trying to get the basics done and can't consider metrics. Also, projects are giving data, but may not see benefits until the Level 4 processes are established and they receive information back on how to do things better.

One organization reported that they performed measurement for a long time. However, in 1989 they received a letter demanding improvement, because their costs were too high, schedules were unpredictable, and quality was poor. They performed an analysis of producing software from the perspective of cost and schedule – that was better than focusing on quality (alone.) They established a solid earned value management process. What did they see in the Software CMM® at that time? They were already doing measurement – so they focused on quality and configuration management because that was new. CMMI[SM] is saying that measurement is important at lower levels. Organization probably shouldn't try to focus on quality alone, but rather should focus on cost and schedule type issues as well.

Another area of key change in CMMI[SM] from Software CMM® is the level of **detail** of the **engineering processes** for product development. The questions were raised:

- Is that detail helpful for process improvement or is it a hindrance?
- Is the lack of focus on software a problem or a benefit?

Engineering processes can be used to demonstrate what might be needed and where one might begin in implementing CMMI[SM]. The CMMI[SM] represents the basics of engineering processes. However, there may be problems encountered during implementation for Information Technology organizations, dot-coms, and/or shrink-wrap organizations, depending on previous experience, types of software development, the criticality of the software and experience with standards in the past. An example was offered of a backend www company with no existing life cycle, no sense of process or project management or defect tracking yet CMMs could help the start-ups if used well.

The CMMI[SM] is not just a set of processes, but a model or a guide to improve processes. It appears some are using the CMMI[SM] as a model for their processes rather than as a model for measuring 'maturity' of processes. Using CMMI[SM] as a model for measuring processes – is a viewpoint from a mature organization. So, what can a mature organization do with CMMI[SM]? Do they have to rewrite processes? This is the wrong approach – it is not a set of processes. When a mature organization looks at a new model and tries to learn from it, somewhere they need to ask if what they have is adequate or is there something missing. There may be new insights or ideas coming from a new model – and once you know the new idea, you want to implement it and gain advantage from it. Improvement can come from within or can come from outside the organization.

Transition to CMMI[SM] means comparing processes against a new model. The CMMI[SM] embedded some of what was learned about maturity in organizations (e.g., PCM, TCM, and

OID). Does CMMI[SM] capture the paths previously taken by higher maturity organizations better than the CMM®?

Issue D: How do organizations with Software CMM® experience, but no CMM® experience in systems engineering, remove stovepipes to implement CMMI?

One SW-CMM® L4 organization engaged their systems engineering people. They pulled together their processes to be consistent with L3 software processes (on one particular program). Now, some system engineering groups exhibit L1 or L2 behavior– and now they have to deal with this. There are clearly defined interfaces, project-by-project, program-by-program. Software processes are institutionalized, but interfaces to systems engineering are chaotic.

Another organization has two levels of system engineering (aircraft level and detailed system level). Those areas that are associated with software have adopted some of the software practices. This hasn't been transferred to the aircraft-level system engineers. The software organization pulls process focused behavior – and the spread is slow/resisted. CMMI[SM] can bring such organizations to the awareness of process-focused needs – especially, when customers say they are going to use CMMI[SM] to evaluate them.

When software and systems are tightly coupled, practices do diffuse – but other engineering areas may have no contact.

In one organization, the software process owner is running the software improvement program across the entire organization. The engineering process improvement effort is just beginning with self-assessments, documenting processes, and evaluating tools. The objective is to provide measures to the CEO as requested.

Another organization described a leap frogging approach. Software engineering was way ahead but systems engineering was working with the software processes. When the company was bought out, it was noted that one of major problems was how different units work together. Systems engineering began an effort to document processes at the organization level to resolve this problem.

Hypothesis: A major difference between low and high maturity organization is that high maturity organizations have the data to prove and demonstrate that their improvements are successful.

Since there is no mandate to use CMMI, one reason for system engineering choosing to go ahead with CMMI[SM] was having seen the success of software engineering using SW-CMM®.

In another case, a software person moved over to systems engineering because he knew the CMM® and improvement methods and they wanted him to implement the systems engineering processes. In another, the software manager was made equal to the systems engineering manager, where previously software reported to systems.

Organizations choosing CMMI[SM] are making a strategic decision. The VP of Engineering was the sponsor in one case. CMMI[SM] should bring another organization closer to looking at business development and evaluation – so sponsorship may be at a higher level.

What made the light go on among senior executives and others? In one case, some people (engineers and leaders) recognized problems in their own area and saw what was happening with process improvements elsewhere in the organization – their initiative drove a bottom-up improvement effort. In another case, an enlightened customer made a huge difference by driving the organization to improvement (e.g., the customer said that they thought it would take a high maturity organization to win the contract). Engineers and program managers have to keep reminding senior executives of customer comments in order to maintain support.

There have been few CMMI[SM] assessments at this point. Many organizations are now looking at CMMI, making improvements, and evaluating internally against CMMI[SM]. Some organizations are planning for formal assessments in a year or two.

One organization is performing a Pilot Assessment. They formed a steering group at the beginning of the year to plan for the assessment. They have had Intro to CMMI[SM] taught on site to about 30 people, then conducted assessment team training. They allowed 3 weeks for the assessment, plus another week for the training. The goal is to evaluate the assessment method and not to focus on capability levels or outcomes. They are looking at 22 Process Areas (PAs). They are performing assessment with internal people and providing the data to SEI. SEI will take data and do analysis for comparison with other pilots. A focus of the pilot is trying to reduce the time on site but maintain the rigor of the evaluation. Also, they will have SEI observers who will prepare reports during assessment. They will capture questions about the model as well as the assessment method (SCAMPI).

Issue E: Selection of CMMI Representation - Staged or Continuous ?

There was a brief discussion of some of the perceived **differences** between the staged representation and the continuous representation of the model.

In the staged representation:

- The concepts can be communicated clearly with senior management
- There is an element of simplicity to the model structure
- All institutionalization understanding is contained to process areas
- If an organization is risk averse and does not have a process culture, the additional elaboration may help them
- The structure supports top down process improvement

In the continuous representation:

- Material is parceled into arbitrary levels
- An organization can pick and choose an area and focus on the particulars of that area
- The 21 processes areas in Level 3 may be overwhelming to new organizations
- An organization can assess progress in specific process areas that are chosen for their business value
- An initial assessment may provide more granularity in results to help in decision-making afterward

There was a discussion of some of the organizational and environmental **factors** that may **influence** use of staged vs. continuous representation.
The staged representation works:

- Best in an organization with strong functional orientation
- In environments that typically do not use Integrated Product Teams, and/or software is not team-based
- In organizations where the management is far removed from engineering (i.e., a closed organization that requires push to management)
- For organizations that cannot use data well, since too much data is reported back from the continuous results
- For very large organizations and differentiated, since the staged results are more easily shared with senior management

The continuous representation works:

- For organizations who may not have a real engineering process established/defined/documented, since they can begin in designing a life cycle
- For organizations who have sophisticated engineering and products, since they may find the granularity and incremental change beneficial
- For organizations that are team-based, IPT-based, and/or management is very close to engineering
- For examination of a very focused area, with few levels of differences

Organizations who come to CMMI and have never done CMM will approach the model representation selection process differently. Some organizations may not see benefits of the staged representation, which software folks take for granted. Some organizations and customers need the constraints of the staged representation; while others find they cannot stand staged.

Organizations with experience using the Systems Engineering CMM and continuous assessments with a Software CMM® experience-base react differently than organizations where software and system were more separate and using different models.
When doing CMMI and communicating adoption principles to higher executive level, this level of management may or may not have engineering background, model knowledge, etc. to fully appreciate the concepts of the model differences. Executives do not want to have to make decisions about subtlety. If an organization chooses to adopt CMMI, they have to figure out how to clearly communicate in concepts that can be understood by senior management (i.e., concepts which are based on business, not models.). In an organization where SW-CMM® has been used, senior management will still probably be conditioned to ask about maturity level ratings.
Even though there are multiple representations, it is not necessary that an organization stay with just one representation or methodology.

Both the continuous and staged representations of the model can help organizations get to Maturity Level 5; however, the model does not help organizations go beyond Level 5. The

focus beyond Level 5 is uncharted territory for the model. This may require going back to TQM roots and looking at organization goals.

An organization may choose to focus on improvement of observable behaviors by applying the generic practices from CMMI. They can be used to communicate and work with improvement in organizations with a history of TQM. TQM was not based on clearly observable behavior; however, CMMs contain only observable behavior.

The CMMI model needs to be used and understood. Selection of the representation, or determining when to do what in terms of process improvement implementation, is coupled to both culture and perspectives of the organization and stakeholders. The model helps because an organization can make choices even within the model for improvement priorities.

Issue F: How will CMMI[SM] apply to commercial or other software only organizations?

What cautions and opportunities does CMMI[SM] provide the commercial software-only organizations?

One organization has been doing improvements based on CMM® principles across the entire company. They have been looking at CMMI[SM] generic practices and common process areas for the whole company and use the engineering Process Areas to improve where applicable. They develop software only, but they still have problems with product lines and problems with requirements. The differences between software-only companies and those working with large systems is one of scale rather than of engineering practices. They haven't seen problems with interpretation of practices – they have handled interpretations of terminology and scaling down practices to work in a small company. For example, they use a general Review Board for requirements control, CCB and process reviews. They relied upon a former SEI staff member (Suzy Garcia) to help with interpretation during the first year of transition from software CMM®. After that, they did their own thing. CMMI[SM] makes explicit what they were doing already in using the CMM® principles across the organization – i.e., the generic practices.

What part of CMMI[SM] might software-only organizations find irrelevant? Very few elements are believed to be irrelevant to most organizations, except for acquisition. All of the engineering practices may be applied to software only organizations. All organizations interpret models to satisfy business goals and objectives. Differences in interpretation come from different size organizations, or those with different outputs or products. What process areas are more important in a particular company? None of the practices are unimportant – some may be more important or implemented differently, depending on the context.

Concern: The maturity levels have gotten very large (large number of Process Areas). Is it possible to extract the process essentials at different levels?
Organizations have to tailor model to their specific context. Determine what you want to accept and what you don't need. This is the key to making the CMMI[SM] work in different organizations. Is it easy to tailor this model? If you don't want to use part of the model, you should document your reasons so you can explain this to an evaluator or assessor. With a large project and teams, you can take slavish obedience to CMMI[SM]. Smaller organizations may need expert knowledge in tailoring the model. CMMI[SM] is larger than SW-CMM, but it may have lost some of the essentials. There is a dichotomy between being lean and providing information that helps users and assessors. Everything in CMMI[SM] is right in line with what are called "lean practices", but it is 700+ pages.

In 97 – high maturity organizations were concerned they were losing senior management sponsorship because had made it to L5. Still true?
These days, senior management sees 6-Sigma, Lean and CMM® as different initiatives, when they are all basically the same. 6-Sigma became an initiative in TQM and was recognized to be of value beyond software and system engineering. It became the focus of all workforce practices. By defining defects in other processes, e.g., marketing, 6-Sigma became the umbrella, and for software and system engineering, another tool for SPC. At one organization, all senior management are green belts in 6-Sigma. They set quantitative goals for their areas. Executives that came from different backgrounds and from different companies are now all working together under this umbrella.

If we are saying that the basic CMM® improvement process can be tailored for any environment, why is the CMMI[SM] model different? Why is it bigger? Case specific tailoring sometimes leaves out specific practices. The assessment time is longer. It isn't clear that a given organization needs to adopt all of the practices in CMMI[SM] and whether that would improve the bottom line.

What practices in the CMMI[SM] are not applicable? The general consensus is that software organizations will apply all of the practices in CMMI[SM]. How is it too heavy? Implementation of CMMI[SM] should be focused on continuous improvement not on assessments. CMMI[SM] is a process model not just a set of best practices to evaluate the maturity of an organization.

Do the engineering PAs add value to software only organizations?

The Risk Management PA will strengthen weak areas that haven't been able to communicate to senior management. The continuous model with its focus on continuous improvement is opening up areas for process improvement. At least one organization is using the CMMI[SM] as a checklist for finding improvement opportunities in their current engineering processes. Another organization adopted the SW-CMM® and SE-CMM® with one single process group. They had been continually comparing the two CMMs, wanting to emphasize the similarities, and CMMI[SM] helps with this. Now everyone is working toward one model.

CMMI[SM] seems to be providing a logical extension to what many organizations already had for software. In many ways, it can be considered a kind of a super-set of the SW-CMM®. If so, why are they separate programs (SW-CMM® and CMMI), without a clear progression from one to the other? Why does SW-CMM® have to be "ended"? Why isn't there a logical progression from software CMM® to CMMI[SM] – training, assessment, everything? We need to ask SEI this question.

Issue G: Do Level 5 organizations develop very different alternative practices ? Are there differences based on organizational structures (e.g., hierarchical vs. flatter)?

This issue was raised in the working group; however, was not discussed during the working group session.

Recommendations for High Maturity Organizations

Recommendations

The group discussion expanded to cover wider maturity with respect to CMMI[SM] adoption rather than just higher maturity. Much of the discussion centered on strategic issues and business decisions of model selection. It was noted that CMMI[SM] offers the wider maturity option and a broader opportunity for integration of disciplines.
As a result of the working group's discussions, the following recommendations for organizations seeking to achieve high maturity were formulated:

Recommendation HM-1 -- High maturity software organizations have some valuable lessons learned that other organizations can use in advancing through the maturity levels and as other organizations mature through CMMI[SM]. Implement measurements early, set up an engineering process group, peer reviews and other forms of verification, process improvement adoption lessons learned.

Recommendation HM-2 -- There are not huge differences between CMMI[SM] and SW CMM®, so that is comforting. Follow Total Quality Management (TQM) principles during strategic planning; identify marketing areas and operational direction. If you have an initiative that crosses the organization (i.e., establishes an "umbrella"), it becomes easier to deploy CMMI[SM] due to a common framework.

Recommendation HM-3 -- Industry has to examine territory beyond maturity Level 5.

Observations

In addition to the observations above, the working group identified a number of other observations relevant to high maturity organizations. These were:

- Level of impact and effort in a high maturity organization should be minimal due to natural extension from SW CMM® to CMMI[SM].
- Selection of the Staged versus Continuous implementation may depend on some cultural, environmental, and management factors.
- CMMI[SM] can be especially beneficial to organizations with less mature Systems Engineering groups.
- CMMI[SM] provides commonality in process improvement across Software and Systems engineering disciplines.
- CMMI[SM] assessments, formal and/or less formal, can be used to assess the feasibility of application of the CMMI[SM] practices and assessment method for an organization.
- CMMI[SM] generic practices can be successfully applied to non-engineering business areas to support process improvement.
- Basically CMMI[SM] has broadened the base. Implementation has more to do with size of the organization than with disciplines in the organization.

It was also noted that the cost for process assessments is very high, and that the SEI needs to provide a less expensive and time-consuming assessment method for CMMI[SM]. The three classes of planned CMMI[SM] assessments were briefly discussed. Class A assessments reflect the rigorous process used in order to achieve ratings and proclaim results to the world. The Class B and C assessments are designed to be more lightweight methods that cost less but are a quick check of where an organization stands against the model.

Recommendations for the SEI

As a result of the working group's discussions, the following recommendations for the SEI were formulated:

Recommendation SEI-1 -- Why is CMMI[SM] not considered SW CMM® Version 3.0? Why is there not a logical progression from SW-CMM® to CMMI[SM] (in models, training, and assessment methods)? In lieu of such a progression, organizations will have a more complex transition.

Recommendation SEI-2 – Develop a CMMI[SM] time-bound release plan for industry – involving all aspects of the organizations (e.g., marketing, Human Resources, etc.) Take an enterprise-wide assessment approach, e.g. Malcolm Baldrige.

Recommendation SEI-3 -- High maturity organizations have learned how to quickly and intelligently implement continuous process improvement. Capture those lessons learned for the sake of others and provide industry a road map to get through the model. That information could be used to fine-tune the model. (e.g. case studies…)

Recommendation SEI-4-- CMM® has established itself as an international de facto standard. It is not desirable to risk that investment by a badly managed transition to CMMI, such that the user community loses faith in CMMs. Defense/aerospace industry community alone cannot keep CMMI[SM] alive and surviving, it has to be accepted around the world. Establish industry-wide support and buy-in, including involvement from the commercial sector. CMMI[SM] has been focused on too narrow of a world (initially). Ensure that software-only organizations can see that the model works for them too and that there are clear guidelines of the model for application to software-only organizations.

The Road to CMMI
What Works, What's Needed

Winifred Menezes Q-Labs, Inc.
6301 Ivy Lane, Ste210
Greenbelt MD 20770
202 262 8703
winifred.menees@q-labs.com

• Context

The author of this paper is a member of the CMMI product team and has experience of CMMI training and assessments both in Europe and the USA.

• Barriers to the uptake of the CMMI

Before discussing adoption mechanisms, it may be instructive to analyze this new technology using Rogers (Rogers, Everett M., *Diffusion of Innovations*, fourth edition, Free Press, New York, 1995) theories on the diffusion of innovation. There are several characteristics of a technology change or innovation diffusion situation that influence the uptake of the new technology. The first is the innovation it self.

- Relative advantage. Although the any of the CMMI models should have a high degree of relative advantage over the prevalent source models, due to the potential cost savings with single assessment, single training, integrated improvement, etc. This advantage is drowning in noise and misunderstanding. Furthermore that is an expectation that the CMMI is an improvement on the SW-CMM – new and better. The world at large was not expecting a model from the SEI that was not perfect on day 1.
- Compatibility. Since the flavor of both the SW-CMM and EIA 731 models is discernable in the CMMI, it would be logical to think that there is a high degree of compatibility between the new model and its predecessor. Potential adopters approach the CMMI with this expectation and find instead familiar concepts or terminology with a different twist, or additions from the other source models

that are then perceived to be superfluous, and difficult to accept. This reduces the perceived degree of compatibility

- Complexity. For the practitioners and managers in the trenches the abstract concepts of process and process management can be complex enough. With more than one model and two architectures, the CMMI has a very high degree of complexity. Typographical errors tend to increase the complexity as well as detract from the credibility of the model. A number of potential adopters attempt to understand the CMMI by "browsing" through the documentation. In a very natural attempt to reduce the complexity, model elements are ignored and the model is reduced to the adopters "comfort zone". The adopter's conclusion then is that the model contains too much superfluous information making use cumbersome.
- Trialability. The intended use of the CMMI is for process improvement, which would be manifested in a CMMI-based improvement program or a CMMI-assessment. Industry working under time-to-market pressures will not find it feasible to allocate the extra effort to pilot the CMMI, unless the decision to transition has been made. Therefore the most feasible method of investigating the CMMI is by attending seminars, tutorials, presentations or training. The conclusions that potential adopters reach is therefore contingent on the perceived message delivered both by the presenters/trainers and by other participants in the event.
- Observerbility. Potential adopters are very interested in hearing about other's experiences with the CMMI. The well-attended CMMI tracks at the recent SEPG is an example of this.

Other relevant characteristics of the diffusion are the communication channels and the decision process. In the software industry decisions to transition to new technology appear to be influenced either by a preponderance of anecdotal or real evidence that a new technology is beneficial, or a customer or legal requirement. Many industrial organizations rely either directly or indirectly on advise from trusted sources, such as consultants. The message regarding the CMMI from these sources is mixed. The reason for this mixed messagee is that consultants themselves are grappling with understanding the new model as well as accepting the fact that even change agents may need to change.

Some anecdotal evidence of customers requiring use of the SW-CMM or CMMI is beginning to be heard, but this is fairly weak. Given that the model is not yet a year old there is no real or evidence of business benefits from using the CMMI. Since there is ROI evidence from use of the SW-CMM, a possible inference is that a CMM-model with a larger scope – both systems and software - would yield larger ROI. Some accept this inference and some don't. Furthermore there is no reliable information

about which companies are have made the decision to or are even considering transitioning to the CMMI.

1 Speeding the adoption of the CMMI

1.1 What's needed

As the CMMI custodians the source of **the message** is the SEI. Other messengers come to the SEI to learn. As the distance between the source and the receiver increase the message gets weaker and diluted. Therefore a strong, consistent, clear and firm message from the "source" is needed. There should be an agreed upon interpretation of all elements of the model. This interpretation is what should be given at all training, seminars, presentations etc. (Since the number of people involved in developing the model was large this in itself is not an easy task.) Typographical and other minor glitches must be removed.

The **presentation** of the two representations of the CMMI as different animals causes problems of understanding and acceptance as well as the death of many trees. In essence the two representations are just different logical views of the same data. A better presentation would be to present the model elements (process areas and practices) separately and then add a couple of chapters, one discussing the logical view called "staged" and the other discussing the logical view called "continuous".

Provide **discipline specific** seminars. Users of one of the source models need to understand the domains of the additional disciplines. This will facilitate the acceptance of the various model elements and hopefully will contribute to a widening of the users comfort zone.

Provide **incentives** to those who will carry the message forward. A simple form of incentives is to lower license fees and training costs. Other more sophisticated (or brutal?) forms could be yearly increases of licenses fees for the source models, to make it economically sensible to transition. CMMI-related training such as domain specific seminars or interpretation seminars could be distributed via CD or the web for free. Licensed assessors could be provided with supporting tools.

Make **evidence** of the model-uptake available by publishing a list of those companies who: are investigating the CMMI, and those who have decided to transition to the model. CMMI marketers need to be able to reference a reliable source of uptake evidence.

1.2 What's new

This sections describes a couple of specific “tools” used when working with the CMMI.

The first tool is a SW-CMM tool converted for use with the CMMI. The tool called **CMMIOnBoard** is a simple self-appraisal tool coupled with an improvement engine (See Appendix 1 for a pictorial representation). The original version of the tool is implemented in Microsoft Excel, though attempts have been made to achieve the same functionality in Microsoft PowerPoint. The “Boarding sheets” – essentially one per Process Area contain the both the generic and specific practices of the CMMI. The sheets or boards are the core of the OnBoard process, which has five activities.

1. Initial Boarding. Appropriate groups use the onBoard sheets to appraise themselves against the practices of individual process areas. The appropriate group is dependant on the organization’s improvement goals. Observations are written on colored post-its which also show degree of fulfillment, red – weakness, yellow – partially fulfilled, green – fulfilled.
2. Action Planning. Yellow and red stickers are input to this activity. The actions are prioritized and improvement begins.
3. Board Updates. Approximately once a month the boards are updated by the group that did the initial boarding or a subset of that group. New observations are written on post-its and placed on the original stickers in such a way that all colors are visible. The intent is to make improvement progress visible.
4. Board Walk. Approximately once a quarter the person responsible for the board (project manager, process owner, EPG chairman) presents the boards to the senior manager. Issues that are slowing process improvement are discussed. Issues common across projects or process areas are identified and planned for.
5. Board Checks. This activity is essentially a light or informal assessment. The boards are input to the assessment, which is expected to occur every six months.

Generally the boards are kept in a central place, so improvement progress is visible, though sometimes company culture or logistics does not allow this. The tool has worked well for organizations using the SW-CMM. The CMMI version exists for both the continuous and staged representations. Activities 1 and 2 have been piloted with out problems. The improvement engine has yet to be piloted.

The second tool is actually a concept has been developed specifically for an organization that has chosen to transition to the CMMI continuous representation. The intention is to integrate improvement planning with business goals and to provide support for choosing which process areas to fo-

cus on. The concept called **Organizational Performance Management** (OPM) has three main steps:

1. Goal setting. This activity is the responsibility of senior management. It should occur at least once a year, but could happen more often. Goal setting consists of establishing a wanted position, identifying key success factors, defining measurable objectives and key performance indicators and lastly developing measurement and date definitions. Coincidently this set of activities would also fulfill specific goal 1 of the Measurement and Analysis (M&A) process area.
2. Action Definition. Two instruments are used to guide action planning. The first Gap Analysis compares the defined measurable objectives and performance indicators with achieved values. The second is Cause-Effect Analysis. A set of cause-effect chains have been developed as guidance. It is possible to map many causes or effects to process areas and even specific practices. The results of these analysis are input to action/improvement planning. Note that all causes do not map to the CMMI, some could be mapped to P-CMM, leading to a need to have people issues integrated into the CMMI.
3. Data Collection and Analysis. The third activity of OPM would fulfill specific goal 2 of M&A.

The benefit of OPM is that the organization clearly sees the link to results and to business goals. Thus increasing the buy-in for process improvement and a reduction of the “process for process sake” syndrome. These concepts are being piloted at the moment.

• Conclusion

Organizations that do not adapt to changing market needs do not survive. Senior managers and change agents know this to be a truism. At the organizations level the question is what to change and when to do it. But organizations are made up of people and therefore change happens one person at a time. The road to CMMI must manage this dichotomy.

• Appendix 1

Initial Boarding

Action Planning

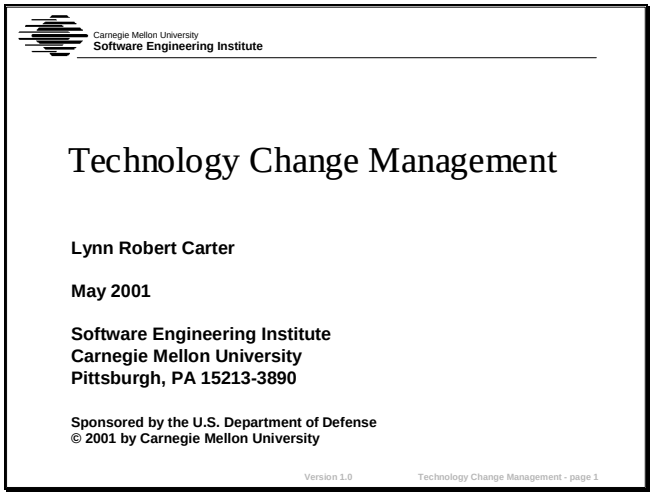
Board Update

Board Walk

Board Check

Appendix B Technology Change Management

Slide 1



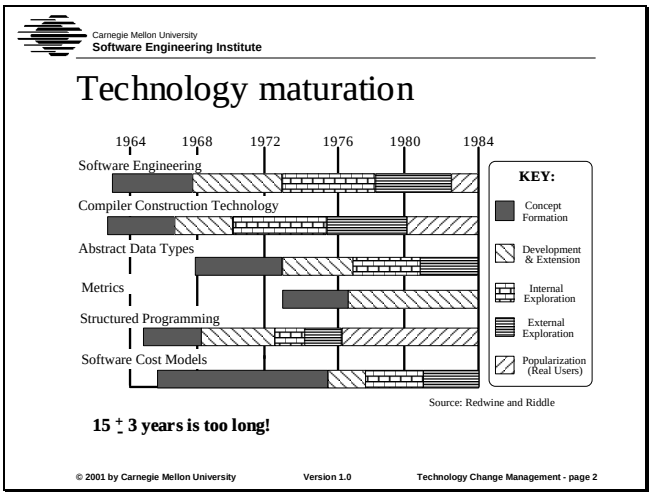
The purpose of this presentation is to lay the foundation for thinking about the various things that the SEI and the community must produce in order to facilitate the deployment and use of CMMI.

Experience has shown that having a better solution is no guarantee of success in the marketplace (e.g., Sony's Beta VCR technology, which captured the commercial television market, failed to capture the lucrative home market due to non-technical issues.) Who you partner with and what additional items are made available are often more important than the technical features of the product itself.

To facilitate preparations for deployment of CMMI, we wish to leverage experiences of others and consider as many of these other factors as possible before we commit ourselves to any specific action plan.

This presentation introduces a number of critical aspects that have been shown to be relevant in other deployment efforts. We believe that by having a shared vocabulary and shared mental models before beginning our deliberations, we will increase our ability to move toward an appropriate plan for moving CMMI from the SEI into broad popular usage.

Slide 2



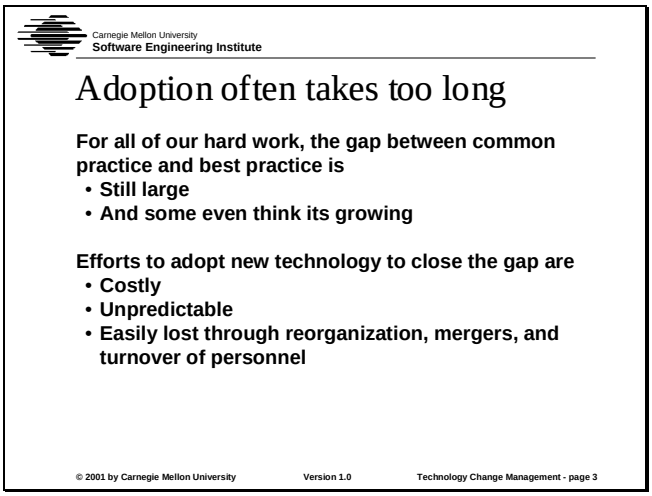
Redwine and Riddle studied the length of time it has taken to move proven software technologies from the first relevant paper to broad popular usage. They concluded that it took from 12 to 18 years for those technologies they studied.

One can raise all sorts of arguments about this study, from questioning their research method and analysis methods to the fact that our world is very different today. Even if we assume that some or even all of these points are true, name **one** software innovation of any real consequence that has taken **less** than 12 years to move from first seminal paper to broad popular usage!

In a field where hardware generations are measured in months (from 18 to 24, depending on your source), 12 **years** is **six generations** and this leads us to wonder what potentials are being missed.

It has been stated that the full power of the Pentium IV will not be realized for years, as none of Microsoft's compilers are optimized to generate code that runs well on the chip. It will be a year or so until new compilers exist that are optimized for the Pentium IV. It will take another year or so for these compilers to make their way into the hands and computers of software developers and longer for them to learn to write code in ways that take full advantage of the chip's features. The operating systems and most applications will have to be rewritten, not just recompiled, for the full potential of the Pentium IV to be realized by the typical computer user. Some have suggested that most of the software running on PCs today are really optimized for CPUs that are no longer available.

Slide 3



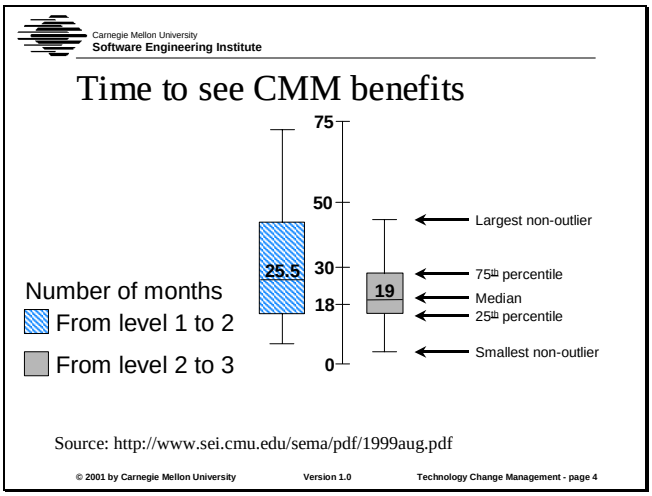
There are people in the software development business who know how to create software that works well. American telephones have been taking advantage of computer-based switches for several decades.

How often have you picked up a telephone handset on a wired telephone and failed to connect a phone call due to software failure in a telephone company switch? When was the last time you had to reboot your PC or had an application freeze? The size and complexity of the software in a telephone switch is far larger than anything in a typical PC.

Data shows that the total lifecycle costs associated with producing software "quick and dirty" are far higher than the costs associated with producing high quality software. Unfortunately, many people believe that being first in the market with a low quality product is worth much more than the P&L numbers would indicate. This lack of discipline and sound business fundamentals have resulted in a number of "dot gones".

At a time of growing application size and complexity, the number of computing graduates from recognized schools as a fraction of new jobs being filled is falling. Too many people believe that one's ability to write code is more important than anything else, even when study after study shows that software developers spend much less than 50% of their time writing code. Convincing developers to use new technologies when they lack the background to understand them is a real up-hill battle.

Slide 4



One of the promises of the CMM was the notion that software development would become less unpredictable and less expensive. A number of studies from a number of organizations support this belief.

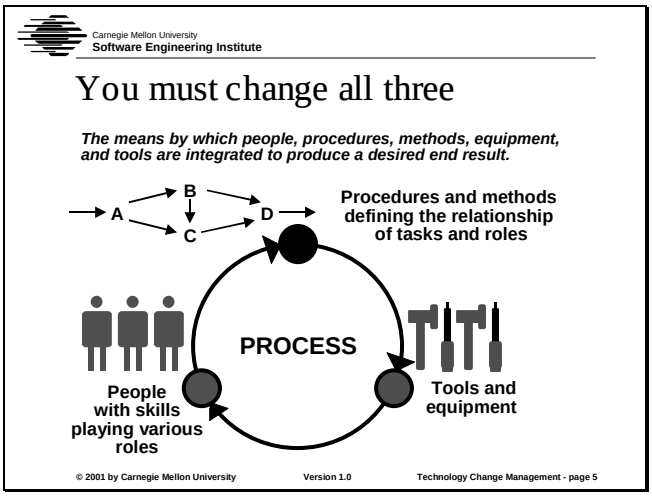
Another interesting fact is that the disciplines of the CMM actually provide other benefits to the organization. Moving from CMM Level One to Level Two takes, on average, 25.5 months. The change required is limited to six key process areas and most of the change is limited to project leaders. The change from Level Two to

Level Three requires addressing seven key process areas, requires revamping a great deal of the work required to get to Level Two, requires change in most all of the development organization, and yet the average time to move to Level Three is only 19 months.

Examining the graphics above also shows that the variation from smallest non-outlier to largest non-outlier has been reduced and the variation from the 25th percentile to the 75th percentile has similarly reduced.

Any way you look at it, these organizations have made more and more complex changes in less time and with less unpredictability.

Slide 5



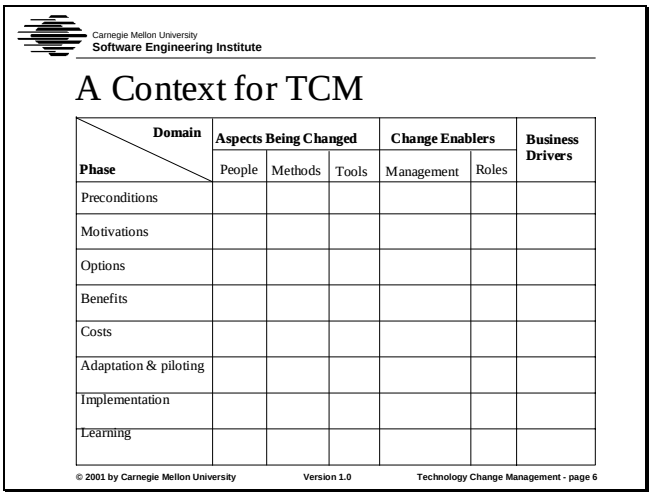
If you are going to change how work gets done, you must change three critical aspects of the organization:

1. The people. If the people's behaviors don't change, nothing will really be different.
2. The Procedures and Methods. Changes of behaviors are important, but if those behaviors are not captured in procedures and methods, different bright people's interpretations of the change is likely to collide with those of others, resulting in waste.
3. Tools. There are some things that people with procedures and methods can do well and there are some things that require tools. Without tools, the full value of a change is not likely to be realized.

You must also change how these three critical elements interact. Process is how a group of people organize themselves, how work flows between them, and how lessons and wisdom from the past influences work. Without good processes, critical lessons tend to be ignored, work handoff is not smooth, time is wasted, work is duplicated or not done at all, and there is no vehicle for things to improve.

As the designer of a new product, we must address these three critical aspects of work and how they are integrated into a total workflow if we are to realize the full benefit of the technology.

Slide 6



A good first step is to organize all of the information at our disposal. With so many lessons and ideas out there, it is easy to become overwhelmed and ignore something important.

The framework provided above is an early attempt to spread out the problem space in order to make it easy to find information relevant to the problem at hand.

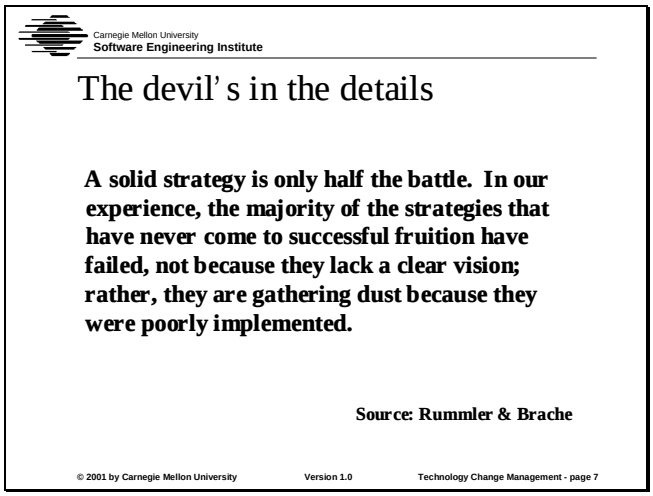
The domains across the top of the framework separate out the various areas of focus, while the phases down the left side spread out the various steps in the life cycle of a major change.

Experience will teach which domains are most critical to a specific firm as it goes from wrestling with whether or not a change should be implemented, through the activities of properly evaluating the motivations, options, benefits, and costs, through adaptation and piloting, to implementation and learning.

It has been argued that Silicon Valley's approach to new technology adoption is to have companies go out of business to be replaced by new companies that employ the new methods and tools.

We believe that the societal costs of such an approach is far too high and is not an option for the government or the military. We believe that a more disciplined approach can result in firms that regularly refresh and reinvent themselves without discarding the bulk of their workforce or walking way from their commitments to their customers and stockholders.

Slide 7



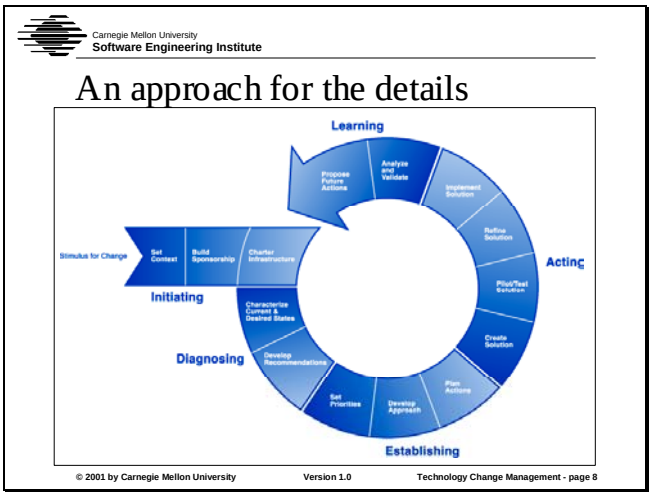
Mintzberg's book on the Rise and Fall of Strategic Planning paints a particularly bleak view of corporate efforts to plan their futures. We believe that Mintzberg has properly recognized that many such efforts fail, but he has elected to ignore and failed to understand those cases where such strategic efforts have succeeded.

Rummler & Brache's Improving Performance (How to Manage the White Space on the Organization Chart) has a much better balance. These authors recognize that this is hard work and that many people have failed to get it right. On the other hand, they have provided solid advice from organizations that have succeeded in efforts to improve.

One of the most important points is that the implementation is just as important as the plan. If the implementation is not being led by the leader and the bulk of the implementation is not being performed by the very best people in the organization, the change is not likely to go well. Leaders have to choose where to expend their resources. If they invest all of their money and hot talent chasing today's business, there will be nothing available to develop new business and prepare the organization to execute that new business. Similarly, not all of the money and talent can be spent on the future with no concern about honoring existing commitment and business needs.

Rather than reinvent what business leaders have learned and others have painfully relearned, possibly at the cost of losing business, why not leverage that knowledge and skill?

Slide 8



Many might wonder why the SEI felt the need to reinvent what Deming calls the Shewhart Cycle (but what many call the Deming Cycle.) What's wrong with Plan, Do, Check, Act?

The purpose of a model is not to accurately represent the real world. Rather, the point of a model is to focus attention on aspects of reality that are important and minimize attention on those aspects of reality that add no value. While the basic Shewhart cycle is fine for expressing the fundamentals, it fails to highlight those aspects of reality that often lead to the failure of continuous improvement. One key feature of the IDEAL model is the role of leadership that is not present in the Shewhart Cycle. Without clear and unambiguous leadership, how can the diverse people playing a wide variety of roles come to compatible new ways of working?

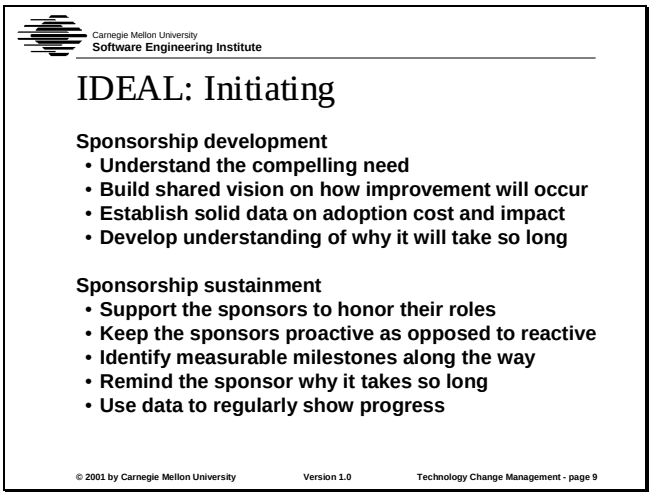
Consider the words of General John Jumper, former commander of Air Combat Command and now the Air Force Chief of Staff. While at ACC, he wrote 14 main tenants that he shared with his troops, which include:

We once had a quality Air Force that was ruined by a program called Quality Air Force.

The product is more important than the process.

I can read each of these statements two ways. I agree that QAF was not implemented well and an inappropriate focus on process at the expense of product is wrong. Is the General opposed to continuous improvement or removing process problems from work flows? We've not seen enough elaboration to know. Improvement requires continuous and clear leadership from the top. Juran says it can't be delegated.

Slide 9



One of the best continuous improvement efforts I have witnessed was one run by a Colonel who knew that the future of his software development organization would depend on how well his people could improve. The reputation of the organization when he arrived was not good and people from the command were constantly looking for ways to leave it for almost any other job on the base, if not elsewhere in the Air Force.

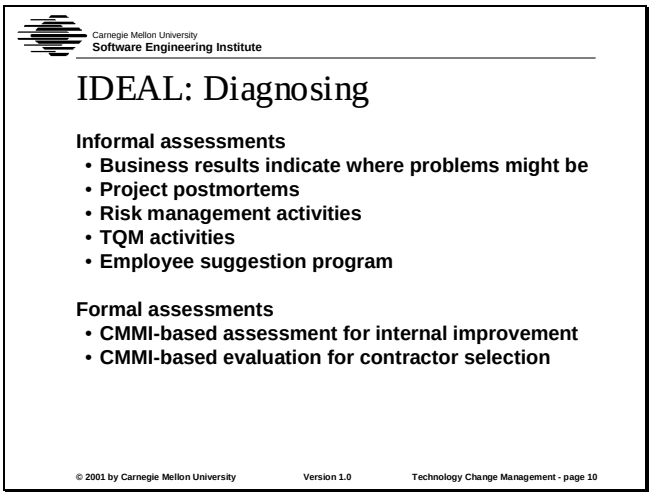
Within a year of his arrival, he had a larger percentage of personnel assigned to process improvement than any organization I had ever visited, and these people were not people with nothing to do. Some of the very best and most experienced people had been assigned to the effort.

When asked how he could afford to make such a large investment in process improvement, he laughed and explained that one of the joys of working for a Level One Command is that there's no way they could tell that he wasn't using every person on development.

He then stated more seriously that there's so much room for improvement that the benefits of the investment would soon exceed the costs. He also pointed out that a large headcount cut was coming and the only way he figured he could survive that cut was to get better as fast as possible, and they better get used to a smaller team.

He led the continuous improvement. They improved dramatically. Their reputation turned around. They were cranking out more and better software with over 30% fewer people. Leadership and the role they play is paramount!

Slide 10



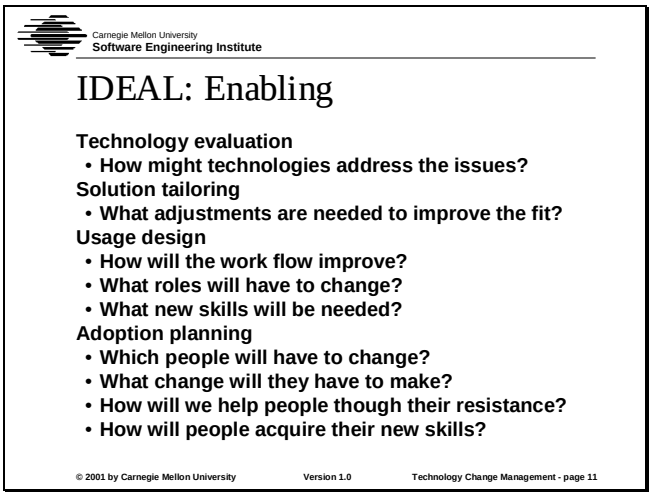
By including the Initiating Phase, the IDEAL model draws attention to the importance of obtaining and sustaining active and informed leadership. Similarly, the attention to the Diagnosing Phase highlights something under the surface in the Shewhart Cycle.

Hidden in Plan, Do, Check, Act is the notion of understanding what is working and what isn't. Without exposing the notion of a more formal approach to diagnosis, people using the Shewhart Cycle can be chaotic in how they plan their next iteration. In fact, some of us believe that true Level Five organizations obtain predictability in technology and process change management by employing some form of statistical control.

The point of the diagnosis phase of the IDEAL Cycle is to focus attention that one needs a good diagnosis before getting too involved with planning the next improvement. It is the SEI's position that a good underlying reference model is an important tool in performing such a diagnosis.

Part of the diagnosis should be a reflection on the past and the lessons that have been learned from previous efforts.

Slide 11

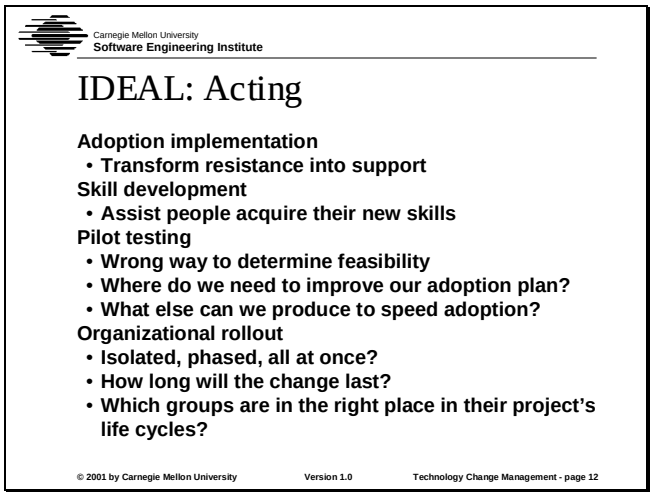


The Enabling Phase is about producing an actionable plan that has the highest probability of addressing the issues brought to the surface during the diagnosing phase. Improvement is usually coupled with some change in tool, method, procedure, or the process by which people, procedures, and tools are integrated to accomplish the work.

Evaluating the options, tailoring the solution, and checking the usage design on the real work the workers at **this** place must perform is important. Few "one size fits all" solutions are worth your time.

Rolling out the improvement means changing the way a number of people do their jobs **while** they are doing them. This is like repairing an airplane in flight. To do it well requires careful planning, preparation, skill, and coordination. Without these things, you are likely to painfully rediscover Rummler and Brache's lessons.

Slide 12



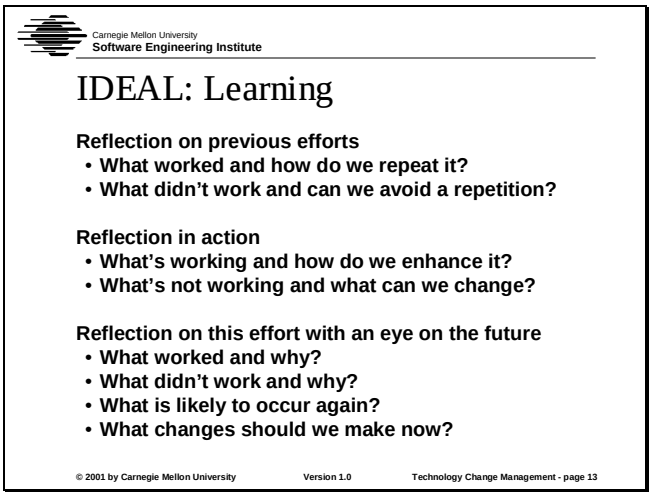
A real improvement is a real project that needs real resources, a budget, project management, executive oversight, and all of the other things that true mission critical projects need.

If this improvement isn't important enough to have these critical resources, why even start?

An improvement implemented by junior people or overloaded people is likely to have problems.

Working on your organization's processes is like working on your brain. You really do want the very best that money can buy. If other things are more important, then you must not be that sick! Wait until your priorities are better, because a poorly implemented improvement is likely to make things worse than they are and will cost more to repair than to do right the first time.

Slide 13



Too often, people appear to have the attitude that once we take care of a few major problems, things will be okay and we all can go back to a more relaxed pace.

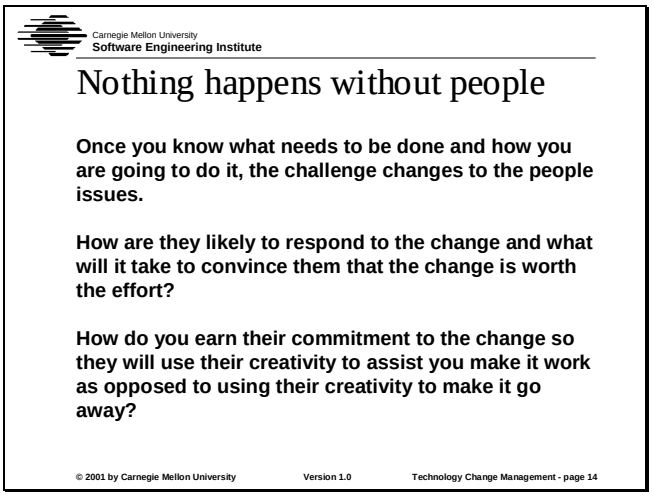
We don't see this. The speed of new technology, size of new applications, and the pressure for shorter cycle times are growing.

The winners are those who recognize that success will go to those who master obtaining predictable benefit from constant change, punctuated by periods of radical change. Anything less positions you for some startup to pass you by in ways that leave you unable to respond.

IBM was so focused on its mainframe business that it was not careful about how it negotiated deals with its software and chip vendors. If it had appreciated what the PC would become, Microsoft and Intel would be divisions of IBM today.

How many times have large firms been overtaken by small startups? This is not a new phenomenon.

Slide 14



It is critical to realize that most workers in creative jobs have very little insight into how work flows through the organization and how interdependent we all are.

While people often have job titles, their job descriptions seldom describe what they really do, with whom they interact, what things are received, and how those things are processed to produce those things that are delivered to others.

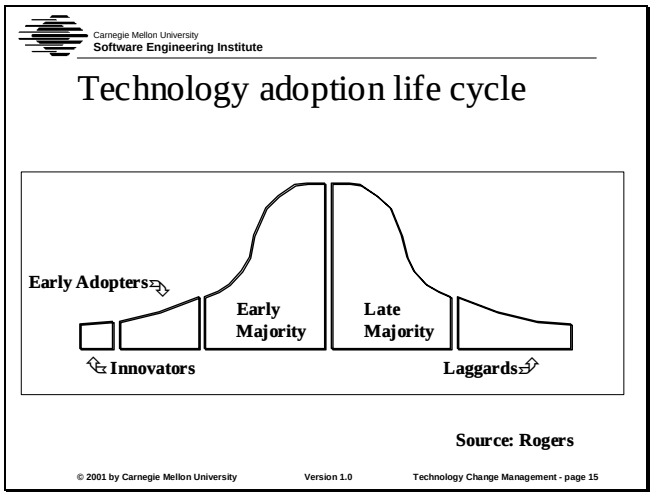
Most workers have defined their own jobs and have entered into a host of relationships and commitments that are not clear to anyone else and maybe not even to themselves. (This is the "White Space on the Organization Chart" about which Rummler and Brache write.) A most awkward challenge is that most workers would be hard pressed to list all of the things they do, all of the people they support, and all of the commitments they have made and must honor. They are successful because they take cues from everywhere to remind them of things to do and commitments to honor.

Most people are event driven and the events that trigger their actions are subtle and difficult to quantify.

Introducing a major change in an organization has the potential to disrupt all of this. Therefore, care must be taken to address all of the obvious things and be open to surfacing and resolving those issues that are more difficult for both you and others to see.

Often, the only sign of these commitments is a sense of nervousness or anger for no apparent reason. In fact, the workers may not be aware what is causing their reactions and feelings. The change team must be prepared to detect these signs and work the situation to a mutually acceptable solution.

Slide 15



Different people react to change differently at different times. Work by Rogers has pointed out that there are five distinct categories of reactions to a new technology adoption.

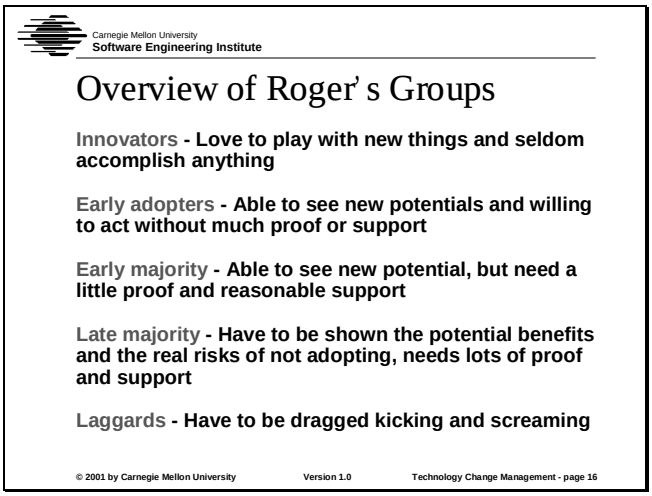
Which group of people do you need to target at what step in your product development and deployment to be successful? Each groups tends to be different and each group tends to look in different places for new ideas, inspiration, and information.

During very early research phases of a project, Innovators can be very helpful collaborators. During the big push for market share, you need to target the Early Majority.

Early Adopters are a most desirable group, but they are not a large part of the market and their interest and success with the product may not be helpful in convincing the Early Majority to adopt.

The problem of moving from Early Adopters to the Early Majority was recognized by Geoffrey Moore in his book, *Crossing the Chasm*. This book has focused a great deal of community attention on Rogers' earlier work.

Slide 16

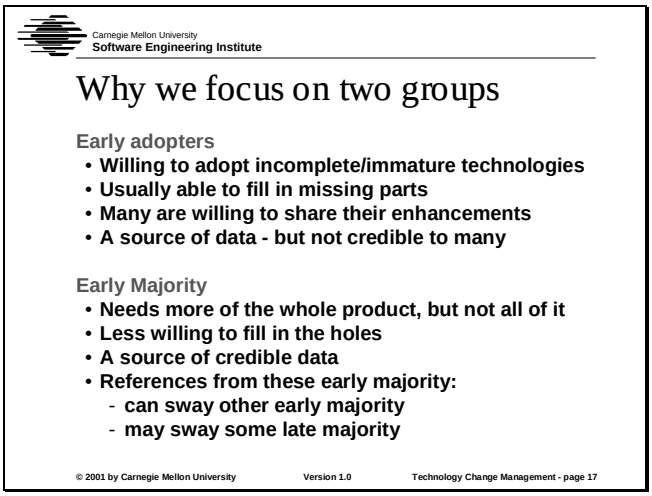


Innovators love to play with new technology. They like being the first to have made something new work. If there's too much known about the technology or too many people playing with it, their interests are drawn to other things. Another challenge with Innovators is that their work seldom results in something that can be used to convince others to try the technology.

Similar to Innovators, Early Adopters like to employ new technology, but they tend to be more goal oriented. These people are talented at seeing new connections and don't require a lot of support to make it work. Some of these adoptions can be used to help convince others of the value of a technology, but there may not be enough of the right kind of data that the majority requires and Early Adopters often work for organizations that are not considered to be "mainline" by the majority.

Early Majority Adopters are like Early Adopters in their interest in employing new technology, but they often require more proof. They are less able to be successful without support and training and may go elsewhere if these items are missing. When they are successful, they are often excellent sources of data to convince others. Late Majority and Laggards are usually more work than they are worth.

Slide 17



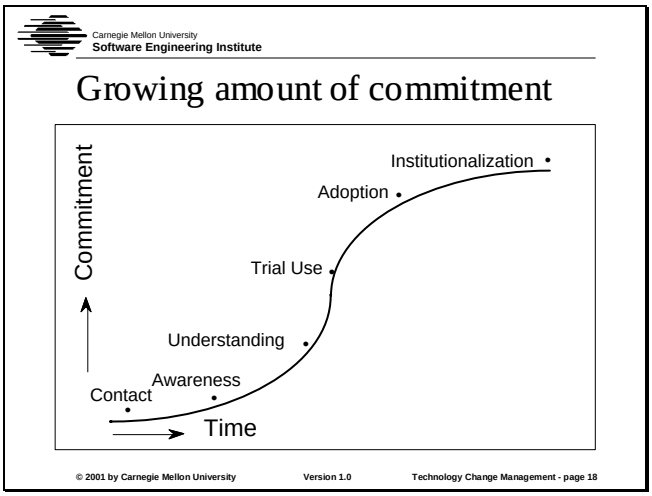
Bringing new technologies and products to a crowded and overloaded marketplace is not trivial. In fact, one of your biggest competitors is apathy. The immediate cost savings of not changing anything is hard to beat when everyone is so overloaded. Finding Early Adopters means you don't have to invest a great deal of time on building up volumes of success stories, each with a careful ROI analysis. Early Adopters are desirable because they usually require very little training and customer support.

Moreover, they may actually help you fix some of the problems with your initial release.

There are only two major drawbacks to a business strategy that focuses on Early Adopters: there aren't enough of them for the kind of growth that many firms desire and they seldom stay with any one technology long enough for a firm to earn back their development investments.

Real market success depends on crossing the chasm over to the Early Majority. Moore's book describes how to do this and motivates this well.

Slide 18



In their paper "Building Commitment to Organizational Change" Conner and Patterson point out a sequence of steps that must be taken in order to bring about a change and the growing commitment needed to take each next step.

It takes almost no commitment to something to be contacted by someone or to become aware of something new.

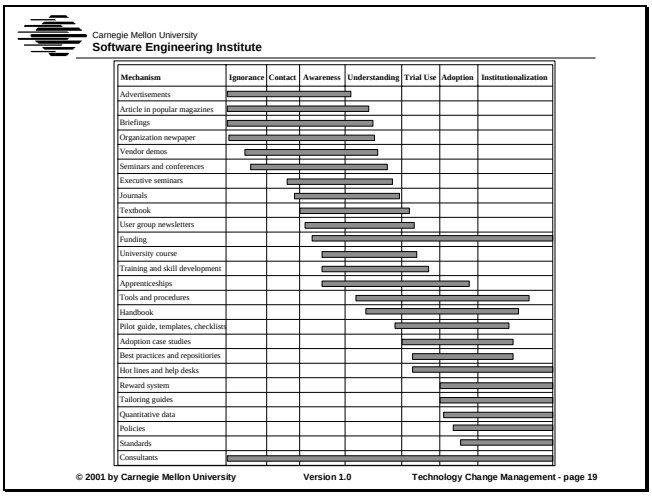
It takes some degree of effort on a person's part to move from the state of awareness to the point of understanding. To expend this effort requires some degree of commitment.

It takes even more commitment to move to a point where a person is willing to try something new at work in the context of all of the other things going on.

The decision to move past a trial usage to true adoption requires even more commitment.

The changes needed to move from adoption to institutionalization, where people do it that way because that's just the way it is done and they have a difficult time thinking of any other way of doing it, requires even more commitment. Too often people believe they have "institutionalized" a change, only to have it evaporate with the departure of one or two people. A truly institutionalized change cannot be so easily lost.

Slide 19



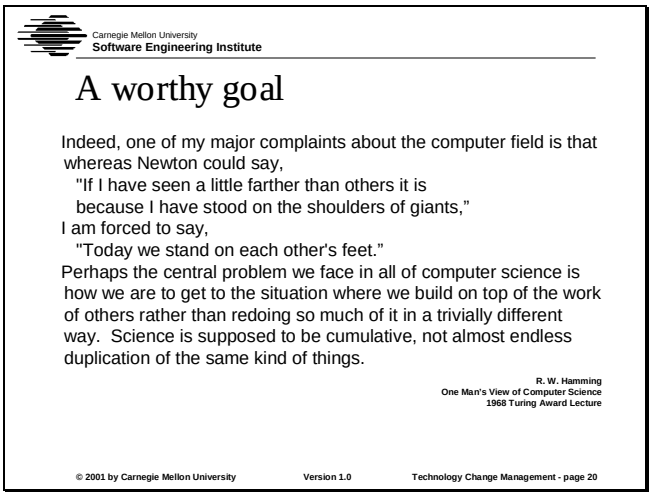
To maximize the probability of success for a new product, a number of supporting mechanisms need to be considered. Each mechanism has a range of usefulness across the Conner commitment curve and the kind of people who can benefit from it. Different people play different roles in the organization being changed. These different roles will require a potentially different collection of mechanisms or versions of the same mechanism. (Experienced professional pilots require different documentation from student pilots, but they must be based on the same underlying procedures and methods.)

No product developer can produce customized mechanisms to address all of Conner's phases, all of Roger's groups, and all of the different roles played by all of the different people with their unique backgrounds and experiences.

The challenge, therefore, is to figure out which subset of these mechanisms is crucial, what subset of all possible mechanisms provides the best ROI, and how to partner with others to spread the burden of the development around.

Distribution partners, value-added resellers, and others will often invest their own money to enhance or create new mechanisms if they see how such an investment will increase their own chances of success. If the opportunities are presented properly, the original product developer only has to produce just enough of the right mechanisms and others will produce the rest.

Slide 20



Taking new products to market is not new. People have been doing this successfully for hundreds of years. The same is true of issues in addressing and managing change.

Unfortunately, most software developers have no formal (or even informal) background in any of these areas. The lack of respect many developers have for the software developers who have come before them is only surpassed by their lack of respect of people in marketing, sales, and management and people trying to leverage the lessons about change. (It's been stated that most software developers have never seen a line of code that they didn't think they could written better.)

Since many people in middle to executive management positions in software-intensive organizations were promoted from the ranks, it is not wise to assume the standard business, marketing, sales lessons, and change management are known or are understood.

Similarly, little is to be gained by insulting these people. Our challenge is to help them appreciate the opportunities and risks with the options they face and support them to the point where they can make an informed choice and successfully lead their organizations.

Appendix C Value Networks

The value network is a graphic representation of all of the organizations, groups, and individuals that are or could be involved in the development, marketing, and use of a technology. The value network is derived from the value chain concept[4].

Traditionally, the value chain [Botkin & Matthews 1992] is used to describe the process by which a new idea gets to market. "The value chain is a sequence of activities during which value is added to a new product or service as it makes its way from invention to final distribution. When a commercially valuable idea takes forever to get from concept to marketplace—or never arrives—the problem is often a weak or missing link (p. 26)." The value chain is composed of several linked stages, which can then be grouped into three phases:

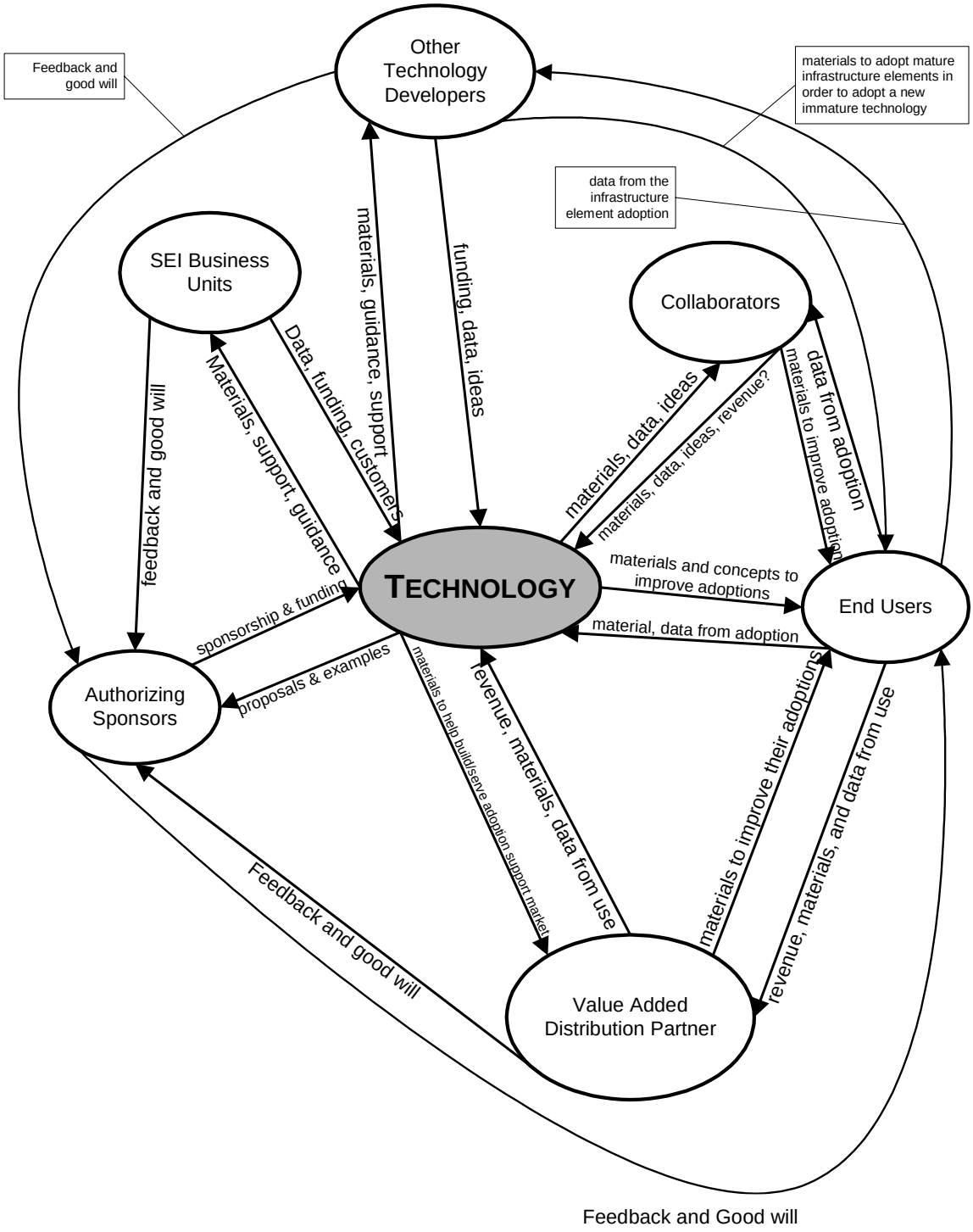
- Phase 1: research, development, design
- Phase 2: production (manufacturing, fabrication)
- Phase 3: marketing, sales, distribution

One key way to navigate the value chain is through partnerships. Ideally, companies specializing in one phase of the value chain would partner with other companies able to complete another phase of the process. For example, large businesses may be weak innovators and/or slow in getting products to market; nonetheless, these bigger corporations can offer smaller partners "stability and credibility, established marketing and distribution channels, and financial resources that are almost unimaginable to strapped young companies (p. 32)."

Determining the value chain for SEI technologies is slightly different, since most SEI technologies are not a commercial-grade product entering the marketplace. However, activities with partners can help to transition a technology into widespread use. In considering the value network for a technology, partnerships may be sought for the following reasons:

- revenue generation, funding for building additional elements of the whole product for majority users
- in-kind resources, a variant to revenue generation, as above
- speed and efficiency, partnerships that decrease the time to widespread use
- influence, partnerships with key players and opinion leaders (whom others reference and follow)

[4] Botkin, J. & Matthews, J. Winning Combinations: The Coming Wave of Entrepreneurial Partnerships Between Large and Small Companies. New York: John Wiley & Sons, Inc., 1992.



Example High-Level Value Network

Four major players are critical in the development and transition of most SEI technologies. These organizations are expected to have early involvement with the SEI technology:

- The SEI technology team (listed as <technology> in the figure)
- Collaborators
- Value-added distribution partners
- Other (non-<technology>) technology developers

This table summarizes the characteristics of these network entities.

Value Network Category	Brief Description	Examples	Involvement
Technology team	Responsible for development, maturation, & transition of the technology into the community	<insert examples for your technology>	Early
Collaborators	External parties who have invested resources (skills or funding) for development & maturation of the technology	<insert examples for your technology>	Early
Value-added Distribution Partners	External parties who see the technology as valuable & are willing to pay (in kind or funding) for use of the technology Primarily involved with applying the technology	SEI Transition Partners who include the technology in their offerings	Early
Other (non-<technology>) Technology Developers	Orgs developing new products who may benefit from use of the technology to deploy support technologies		Early
SEI Business Units	Enabling portions of SEI that support maturation/transition of technologies without actually being on the team	-Licensing -Events Management	Mid-term
Authorizing Sponsors	Internal & external roles who determine how resources will be allocated, including how much will be allocated to the technology	-SEI Director's Office -SEI Joint Program Office	Mid-term
End Users	Parts of an organization that adopt technologies on a regular basis		Early (via Value-Added Partners) or Mid-term

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13. ABSTRACT (MAXIMUM 200 WORDS)

In May 2001, the Accelerating Software Technology Adoption (ASTA) Initiative of the Software Engineering Institute (SEI) piloted a workshop to support the management of technology transition and to capture feedback from adopters of the Capability Maturity Model® Integration (CMMI[SM]) Product Suite. The workshop, titled "The Road to CMMI: What Works, What's Needed?," served as both a tool for improving the transition of the CMMI Product Suite and as the first pilot of the Technology Transition Workshop (TTW) series.

The workshop was a success, generating 75 prioritized recommendations of what works, what doesn't, and what's needed for an organization to successfully transition to the CMMI Product Suite. Feedback was very positive, with participants indicating that the workshop provided beneficial information they could put into practice at their home organizations. Since the workshop, ASTA's findings have been disseminated to the broader CMMI adopter population through the CMMI Technology Conference and User Group held in November 2001, and the on-going series of CMMI Transition Workshops held in conjunction with the National Defense Industrial Association (NDIA). The findings are also available on the TTW Web site: http://www.sei.cmu.edu/products/events/ttw/. Organizations contemplating the implementation of the CMMI Product Suite, change agents for those organizations, and researchers in technology transition and adoption will be interested in this report.

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