Journal of Knowledge Management 2006 Vol 10 Iss 1 pp 69-80

KM YOUR WAY TO CMMI

Rony Dayan – Director of Knowledge and Intellectual Property
Israel Aircraft Industries (rdayan@iai.co.il)
Stephen Evans - Head, International Ecotechnology Research Centre
Cranfield University, Department of Enterprise Integration (steve.evans@cranfield.ac.uk)

Abstract

This paper was written to familiarize people involved with either field – Knowledge Management (KM) or Capability Maturity Model Integrated (CMMI^{SM}) with the other one in surfacing their similarities.
The KM framework used for this comparison is the one established and used at Israel Aircraft Industries, while the CMMI^{SM} source of information is none but the original document produced by the CMMI^{SM} Product Team at the Carnegie Mellon University, as well as papers published on the subject.
Knowledge Management is a rather young discipline promising to maximize innovation and competitive advantage to organizations that practice knowledge capture, documentation, retrieval and reuse, creation, transfer and share to its knowledge assets in a measurable way, integrated in its operational and business processes.
The Capability Maturity Model Integrated deals with the ways an organization has to follow, in order to maintain well mapped processes, having well defined stages, because of the assumption that in mature organizations, it is possible to measure and relate between the quality of the process and the quality of the product.
Though KM and CMMI^{SM} take different approaches to the achievement of competitive advantage, they seem to be supporting as well as dependent of each other as this article will attempt to show.
Practitioners as well as researchers in the field of Knowledge Management and in the implementation of the CMMI^{SM} standard will find comfort in realizing how mutually supportive are these two fields.

Introduction

In the hypercompetitive environment we are bound to perform, we find the knowledge we have and the usage we make of it to be the main source of our competitive advantage. A major part of this knowledge refers to defined and documented processes in the various competence centres of the company (some of them technological while others are procedural). The rest remains in the generalized term of tacit knowledge which refers to the experience of the company's people, in their head and memory or at the tip of their fingers.
Knowledge management (KM) is a rather young discipline promising to maximize innovation and competitive advantage to organizations that practice knowledge capture, documentation, retrieval and reuse, creation, transfer and share of its knowledge assets in a measurable way, integrated in its operational and business processes.
The Capability Maturity Model Integrated (CMMI^{SM}) deals with the ways an organization has to follow, in order to maintain well mapped processes, having well defined stages, because of the assumption that in mature organizations, it is possible to measure and relate between the quality of the product and the quality of the process.
Though KM and CMMI^{SM} take different approaches to the achievement of competitive advantage (Ramanujan & Someswar, 2004), they seem to be supporting as well as dependent of each other and this is the basis of this article.

Knowledge Management

Knowledge Management is the systematic effort to capture, store, retrieve, reuse, create, transfer and share knowledge assets within an organization, in a measurable way completely integrated in its operational and business goals, in order to maximize innovation and competitive advantage. Knowledge can be classified as explicit or tacit. Explicit knowledge would include such things as documented processes, directives, standards, or patents. Tacit knowledge is the knowledge that people carry around in their mind; it is their experience and their expertise and transforming it into an organizational asset is not straightforward. A company's greatest assets may not lie in the products they make but the knowledge of the people who produce those products.

Therein lies the importance of having a method of collecting, managing, and maintaining that knowledge. Knowledge management is implemented in various organizations using different frameworks (Heisig, 2002). One that has been designed and run by the writer of this article who is the Director of Knowledge and Intellectual Capital of Israel Aircraft Industries, is built as a comprehensive program around a full life cycle of the knowledge – starting from the creation of knowledge, the capture and documentation of it, its retrieval for reuse and its sharing (Dayan, 2003). Specific processes have been defined to perform those activities and to measure their influence and possibly, their concrete effect on business results. These are:

- New knowledge creation
    - Knowledge extracted from the innovation process
    - Knowledge from the new product initiative (NPI) process

- Knowledge capture and documentation
    - Disciplinary knowledge capture
    - Lessons learned from debriefings
    - Organizing for content management

- Knowledge retrieval for reuse
    - Fostering the knowledge of core competence centres
    - Using past knowledge in the generation of technical and price proposals
    - Establishing business and technological knowledge bases

- Knowledge sharing
    - Communities of practice
    - Generating good practices
    - Using portals to share knowledge

This comprehensive KM program is measured at three levels – the performance level which shows how much of what needs to be performed out of the KM procedures, is actually achieved; the throughput level, to monitor that the KM activity was indeed efficient; and finally, the operational or business result which is the aim of the KM program if indeed it is to support the organization's goals. This measurement process enables the management of the program and its constant connection to the operational activity as the worst that can happen to such a program is its detachment from everyday life (Kristensen & Westlund, 2004).

The concept of taming knowledge and putting it to work is not new; phrases containing the word knowledge, such as knowledge bases and knowledge engineering, existed before KM became popularized. KM is unique because it focuses on the individual as an expert and as the bearer of important knowledge that he or she can systematically share with an organization. KM supports not only the know-how of a company, but also the know-where, know-who, know-what, know-when, and know-why. In that, it is the mechanism that centralises the documentation about the various processes involved with the operation of the company (Davenport, Harris, et al., 2001).

As we describe the more formal processes companies have to follow in order to be considered consistent with the more recent quality standards, it will be evident that many of these requirements are actually answered by complying with KM procedures.

From CMM[1] to CMMI[SM 2]

A model is a simplified representation of the world. Capability Maturity Models (CMMs) contain the essential elements of effective processes for various applications. Since 1991, Capability Maturity Models have been developed for a myriad of disciplines. The SW-CMM was developed by the Software Engineering Institute of the Carnegie Mellon University, in collaboration with the software community, and since its publication in 1991 has become a de facto standard for assessing and improving software processes. Models for software acquisition, workforce management and development, and Integrated Product and Process Development came later. Although these models have proven useful to many organizations, the use of multiple models has been problematic.

The CMM Integration project was formed to sort out the problem of using multiple CMMs by combining their models into a single improvement framework for use by organizations pursuing enterprise-wide process improvement (Carnegie Mellon University). The CMMI^{SM} -SE/SW integrates the SW-CMM with the Systems Engineering Capability Model and concepts from Integrated Product and Process Development (IPPD) to provide a framework for improving and evaluating capability maturity across both software and systems engineering aspects of an organization. Like other CMMs, Capability Maturity Model Integration (CMMI^{SM}) models provide guidance to use when developing processes. CMMI^{SM} models are not processes or process description; the actual processes used in an organization depend on many factors, including application domain(s) and organization structure and size.
A process is a set of practices performed to achieve a given purpose; it may include tools, methods, material and/or people. A process is therefore a leverage point for an organization's sustained improvement. Your workforce, in general is as good as it is trained to be. Getting better performance, higher yield, or improved throughput cannot only be the result of harder work. It has to come out of smarter work – such, for which the process has been analyzed, improved and hopefully optimized (Armistead, 1999).
The purpose of CMMI^{SM} is then, to provide guidance for improving the organization's processes and its ability to manage the development, acquisition, and maintenance of products and services. CMMI^{SM} places proven approaches into a structure that helps the organization appraise its organizational maturity or process area capability, establish priorities for improvement, and implement these improvements.
The Capability Maturity Model Integrated (CMMI^{SM}) offers you the means to improve your organization's ability to manage the development, acquisition and maintenance of products and services. As such it has the potential to significantly improve your organization's efficiency and profitability. CMMI^{SM} enables you to assess your organizational maturity and process area capability. It identifies priorities for improvement, and provides guidance on the implementation of these improvements.
The US Department of Defence requirement, as stated in DoD 5000.2-R as follows, doesn't leave much of a choice to industries interested to do business with the largest and most important world customer:
"At a minimum, full compliance with SEI Capability Maturity Model Level 3, or its equivalent in an approved evaluation tool, is the Department's goal".

CMMI^{SM} Reference models

CMMI^{SM} models are designed to describe discrete levels of process improvement (CMMI Product Team 2002). There are 4 disciplines for which CMMI models are developed:

- Systems engineering
- Software engineering
- Integrated Product and Process Development
- Supplier sourcing

As stated, the CMMI^{SM} is an integrated model having its sources in all these disciplines. The result is not necessarily inclusive of them all, so that the alternative reference models comprising of the CMMI could be either of the following:

- Systems Engineering + Software Engineering
- Systems Engineering + Software Engineering + Integrated Product and Process Development (IPPD)
- Systems Engineering + Software Engineering + Integrated Product and Process Development (IPPD) + Supplier Sourcing (SS)

The five maturity levels

CMMI^{SM} in its staged configuration is being measured at five different levels. A maturity level is a well-defined plateau of process growth. Each maturity level stabilizes an important part of the organization's processes. Maturity levels consist of a predefined set of process areas. The maturity levels are measured by the achievements of the goals that apply to each predefined set of process areas. The model consists of five maturity levels, each layer being the basis for ongoing process improvement:

- Initial – Process unpredictable, poorly controlled, and reactive.

- Managed – Process characterized for projects and is often reactive.
- Defined – Process characterized for the organization and is proactive
- Quantitatively managed – Process measured and controlled.
- Optimized – Focus on process improvement.

The very building of capability measurement in superseding levels has a value in itself. Indeed, reaching a higher capability without the mastering the confidence of the basic ones is like making a pyramid stand on its head and hopping it to remain stable and to reflect the situation across the organization and not merely at chosen locations. The organization can achieve progressive improvements in its maturity by first achieving stability at the project level and continuing to the most advanced-level, organization-wide continuous process improvement using both quantitative and qualitative data to make decisions.

Process areas for CMMI^{SM}

A process area consists of a set of related practices in an area that, when performed collectively, satisfy a set of process goals considered important for making significant improvement in that area.
Process goals are statements about process areas describing what a process area should achieve, to make significant process improvements.

Process areas can be grouped into 4 categories:

- Engineering
- Project management
- Process management
- Support

In its staged representation, CMMI^{SM} is addressing process areas according to the maturity level:

Level	Focus	Process areas
1 Initial		
2 Managed	Basic project management	Requirements Management Project Planning Project Monitoring and Control Supplier Agreement Management Measurement and Analysis Process and Product Quality Assurance Configuration Management
3 Defined	Process standardization	Requirements development Technical solution Product integration Verification Validation Organizational Process Focus Organizational Process Definition Organizational Training Integrated Project Management for IPPD Risk Management Integrated Teaming Integrated Supplier Management Decision Analysis and Resolution Organizational Environment for Integration
4 Quantitatively managed	Quantitative management	Organizational process performance Quantitative project management
5 Optimizing	Continuous process improvement	Organizational innovation and deployment Causal analysis and resolution

Ahn & Chang (2004) refer to process knowledge as the knowledge associated with the activities performed in each stage of a value chain from inbound logistics to customer care. Compared to product knowledge, which is directly related to the provision of products or services, process knowledge is a kind of glue that brings the organization assets together and enables the achievement of better financial and organizational and market performance (Day, 1994).

The KM aspect of CMMI^{SM}

CMMI^{SM} model components

CMMI^{SM} models are designed to describe discrete levels of process improvement. In the staged representation, maturity levels provide a recommended order for approaching process improvement in stages.
As illustrated in Figure 1, maturity levels organize the process areas. Within the process areas are generic and specific goals as well as generic and specific practices. Common features organize generic practices.

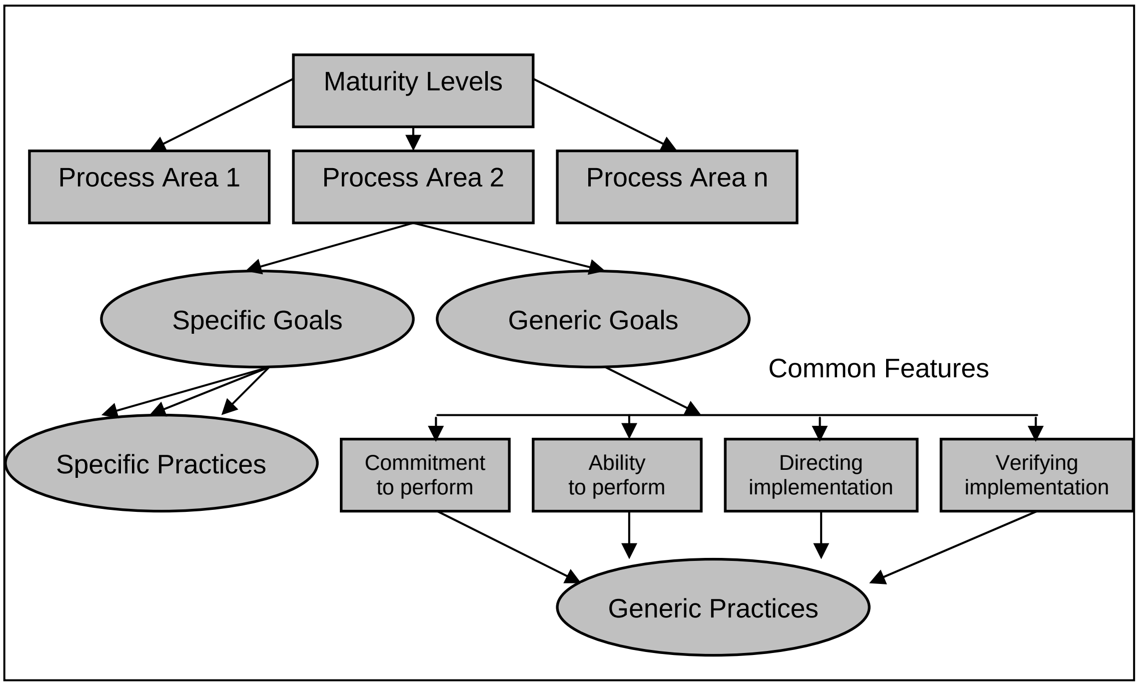

Figure 1: CMMI^{SM} Model Components

This representation focuses on **good practices**[3] your organization can use to improve processes in the process areas that are within the maturity level it chooses to achieve. Before you begin using a CMMI^{SM} model for improving processes, you must map your processes to CMMI^{SM} process areas. This mapping enables you to control process improvement in your organization by helping you track your organization's level of conformance to the CMMI^{SM} model you are using. We shall examine now the various process areas relevant to the different CMMI^{SM} levels and look for the appropriate KM procedures that could support them.

CMMI^{SM} Level 2

Requirement Management is the first process area addressed at this level. The purpose of this process area is to manage the requirements of the project's products and product components and to identify inconsistencies between those requirements and the project's plans and work products. Part of the management of requirements is to document requirements changes and rationale and maintain bidirectional traceability between source requirements and all product and product-component requirements. The use of the principles of **content management**[4] or even the services of a document management system will facilitate very much this activity.

Project planning is another process areas addressed at this level. It includes developing estimates (cost, schedule and risk estimates). If KM had been used, previous experience with similar projects could be tapped into in order to develop a more realistic estimate. The KM program we are dealing with is doing just that, and the additional purpose there is to use prior information to generate **technical and price proposals**[5] in a controlled way.
KM could be enhanced by CMMI[SM] at this level due to the documentation that is required by CMMI[SM]. That knowledge should be collected anyway, but using KM techniques, it would then be organized for later use. KM should be applied to the lowest maturity areas since it is at this level that you would be looking for repeatability. With good documentation and wise use of resources, KM can enhance the CMMI[SM] effort.
The specific goal of developing a project plan (Specific Goal #2, required at this level of CMMI[SM]), is supported by seven specific practices:

- Establish the budget and schedule
- Identify project risks
- Plan for project resources
- Plan for needed knowledge and skills
- Plan stakeholder involvement
- Establish the project plan
- Plan for data management (for Integrated Product and Process Development)

Planning for data management fits very well with the KM activity of **content management** which aims at organizing the project data in an ontologically built hierarchical information tree.
When integrated teams are formed, project data includes data developed and used solely within a particular team as well as data applicable across integrated team boundaries if there are multiple integrated teams. Data are the various forms of documentation required to support a program in all of its areas (e.g., administration, engineering, configuration management, financial, logistics, quality, safety, manufacturing, and procurement). The data may take any form (e.g., reports, manuals, notebooks, charts, drawings, specifications, files, or correspondence). The data may exist in any medium (e.g., printed or drawn on various materials, photographs, electronic, or multimedia). Data may be deliverable (e.g., items identified by a program's contract data requirements) or non-deliverable (e.g., informal data, trade studies and analyses, internal meeting minutes, internal design review documentation, lessons learned, and action items). Distribution may take many forms, including electronic transmission. Nevertheless they all support the program in all of its areas.
The data requirements for the project should be established for both the data items to be created and their content and form, based on a common or standard set of data requirements. Uniform content and format requirements for data items facilitate understanding of data content and help with consistent management of the data resources.
The reason for collecting each document should be clear. This task includes the analysis and verification of project deliverables and non-deliverables, contract and non-contract data requirements, and customer-supplied data. Often, data is unnecessarily collected with no clear understanding of how it will be used. This is wrong as **knowledge capturing**[6] is costly and should be performed only when needed.

Another process area at this level is Measurement and Analysis. This process area supports all the others by providing specific practices that guide projects and organizations in aligning measurement needs and objectives with a measurement approach that will provide objective results. These results can be used in making informed decisions and taking appropriate corrective actions. The purpose of this process area is therefore to "develop and sustain a measurement capability[7] that is used to support management informational needs". This process area in itself supports the need for knowledge management. It shows the need for a measurement procedure to be developed and recorded for future use. Something has to be established in order for it to be measured against in the future.

Configuration management is a process area that applies not only to projects, but also to organization work products such as standards, procedures, and reuse libraries. The KM activity related to **new product initiative (NPI)**[8] process deals with the organized documentation of information developed all along the project life cycle, for the purpose of the project itself at future stages, or for the benefit of other projects who can reuse it.

CMMI^SM Level 3

At CMMI^SM level 3, organizational process definition involves development and maintenance of the organisation's standard processes, along with related process assets (Carnegie Mellon University, 1994). This is considered as the "defined" level of CMMI^SM and activities would be using the organization's historical data if this information was available due to KM activity. The generic goal of institutionalizing a defined process (Generic Goal #3, required at this level of CMMI^SM), is backed up by two generic practices:

- Generic Process #3.1 Establish a Defined Process
- Generic Process #3.2 Collect Improvement Information

The collection of work products, measures, measurement results, and improvement information derived from planning and performing the requirements management process to support the future use and improvement of the organization's processes and process assets, fits very well with the KM procedure of knowledge capture.

The CMMI^SM category of Process Management starts to come into effect at the 3^rd level. Process Management process areas contain the cross-project activities related to defining, planning, resourcing, deploying, implementing, monitoring, controlling, appraising, measuring, and improving processes. The basic Process Management process areas provide the organization with a basic capability to document and share **best practices**[9], organizational process assets, and learning across the organization.

The Organizational Process Focus process area helps the organization to plan and implement organizational process improvement based on an understanding of the current strengths and weaknesses of the organization's processes and process assets. Candidate improvements to the organization's processes are obtained through various means. These include process-improvement proposals, measurement of the processes, **lessons learned**[10] in implementing the processes, and results of process appraisal and product evaluation activities.

KM standardized processes for **sharing knowledge**[11] (as listed above to be the communities of practice, the derivation of good practices and the usage of portals), and for **knowledge capture and documentation**[12], could enhance and support the CMMI^SM implementation.

Another process area relevant to this level is the one of Technical Solution within which falls the specific practice of performing Make, Buy, or Reuse Analyses (Specific Process #2.4). This practice will rely very much on the existence of a well documented set of competence centres. KM would normally include among its procedures the management of those **competence centres**[13], using attributes quite similar to those listed in the CMMI^SM practice.

CMMI^SM Level 4

Organisations establish quantitative goals for product and process quality at CMMI^SM level 4. Organisational process performance means an organisation creates well-defined and consistent measures for its processes and products. This serves as a foundation for quantitatively managing performance. This is the level of quantitative management and at this level, the organization is managed and you should be able to "expect" results. Defined organizational processes are present and used in new projects. The information gained and organized through KM will help the process run more smoothly, and with less effort due to the information being accessed through an organized manner.

One of the process areas relevant to this level is the one of Organizational Process Performance. The purpose of Organizational Process Performance is to establish and maintain a quantitative understanding of the performance of the organization's set of standard processes in support of quality and process-performance objectives, and to provide the process performance data, baselines, and models to quantitatively manage the organization's projects.

Process performance is a measure of the actual results achieved by following a process. The expected process performance can be used in establishing the project's quality and process-performance objectives and can be used as a baseline against which actual project performance can be compared.

The associated process performance models are used to represent past and current process performance and to predict future results of the process.

When the organization has measures, data, and analytic techniques for critical process characteristics, it is able to do the following:

- Determine whether processes are behaving consistently or have stable trends (i.e., are predictable)
- Identify processes where the performance is within natural bounds that are consistent across process implementation teams
- Identify processes that show unusual (e.g., sporadic or unpredictable) behaviour
- Identify any aspects of the processes that can be improved in the organization's set of standard processes
- Identify the implementation of a process which performs best

Similar activities are being performed in the implementation of the related KM program where the performance of processes, their throughput and relation to operational and business results are being measured in order to continuously improve them. Some of the criteria for the selection of **measures for KM procedures**[14] as well as for organizational performance are:

- Relationship of the measures to the organization's business objectives
- Visibility that the measures provide into the process performance
- Availability of the measures
- Extent to which the measures are objective
- Frequency at which the observations of the measure can be collected
- Extent to which the measures are controllable by changes to the process
- Extent to which the measures represent the users' view of effective process performance

CMMI^SM Level 5

At CMMI^SM level 5, the entire organisation focuses on continuous process and technology improvement, which occurs through incremental or transformational advancement. Process and technology improvements are planned and managed as ordinary business activities and their purpose is to optimize the organisation's overall activity. One of the two process areas relevant to this level is the one of Organizational Innovation and Deployment. The purpose of Organizational Innovation and Deployment is to select and deploy incremental and innovative improvements that measurably improve the organization's processes and technologies. The improvements support the organization's quality and process performance objectives as derived from the organization's business objectives.
Quality and process-performance objectives that this process area might address include the following:

- Improved product quality (e.g., functionality, performance)
- Increased productivity
- Decreased cycle time
- Greater customer and end-user satisfaction
- Shorter development or production time to change functionality, add features, or adapt to new technologies

Achievement of these objectives depends on the successful establishment of an infrastructure that enables and encourages all people in the organization to propose potential improvements to the organization's processes and technologies. Higher levels of KM implementation also aim at involving the actual people of the organization and not only via their management.

The potential barriers contemplated for the CMMI^SM implementation at level 5 deploying process and technology improvements are similar to those faced by the implementers of KM and they include:

- Turf guarding and parochial perspectives
- Unclear or weak business rationale
- Lack of short-term benefits and visible successes
- Unclear picture of what is expected from everyone
- Too many changes at the same time
- Lack of involvement and support of relevant stakeholders

This is why KM implementation is often regarded as a cultural change. An organization implementing KM would therefore have an easier job achieving the top CMMI^SM level (and vice-versa).

Conclusions

As observed by Boehm (2000), CMM used to separate the software engineer from the concern for system architecture and software requirements – "Analysis and allocation of the system requirements is not the responsibility of the software engineering group but is a prerequisite for their work" (Paulk, Weber, et al., 1995). While the hardware and systems engineer sat around the table discussing their previous system architecture, the software engineers sat on the side, waiting for someone to give them a precise specification they could turn into code. CMMI^{SM} has provided software engineers with a seat at the centre table, making them into concurrent stakeholders for the Customer and Product Requirements, Technical Solution, Project Planning, Supplier Agreement Management, Risk Management, and Decision Analysis and Resolution.
Expanding from usage of a single-discipline model to a CMMI^{SM} model with multiple disciplines provides an opportunity for significant reuse of existing process assets (Curtis, Phillips, et al., 2002). This is where KM comes into the picture, defined by (Harigopal & Satyadas, 2001) as a discipline that provides the strategy, process, and technology to share and leverage information and expertise that will increase our level of understanding, to more effectively solve problems, and make decisions. It does it with procedures as "knowledge capture" - documenting existing processes, or "good practices" – disseminating and leveraging experienced procedures.
CMMI^{SM} enables you to assess your organizational maturity and process area capability. It identifies priorities for improvement, and provides guidance on the implementation of these improvements. On the other hand, applying KM can bring enormous tangible and intangible benefits.
These two area studies have different scope but similar methodologies such as maturity models and the evolvement through the processes. Interestingly, in the recent studies, one has taken effects on the other. We can see CMMI^{SM} levels and models applied to some KM models, and KM techniques applied to CMMI^{SM} activities. No matter how they affect each other, it is believed that the debates and learning from each other should improve them both. Further, to learn from both of the two studies can obtain the knowledge and clear concept of the operation of the organization as well as problem solving capability. When Knowledge Management is used with the Capability Maturity Model Integrated, the organization becomes more efficient and effective in the development of the projects they are used on.

References

Ahern, D.M., Clouse, A., and Turner, R. (2001), *CMMI Distilled - A Practical Introduction to Integrated Process Improvement*, Addison-Wesley,

Ahmed, P.K., Lim, K.K. and Zairi, M. (1999), 'Measurement Practice for Knowledge Management', *The Journal of Workplace Learning,* Vol. 11, No. 8, pp. 304-311.

Ahn, J.-H. and Chang, S.-G. (2004), 'Assessing the contribution of knowledge to business performance: The KP^3 methodology', *Decision Support System,* Vol. 36, pp. 403-416.

Armistead, C. (1999), 'Knowledge Management and Process Performance', *Journal of Knowledge Management,* Vol. 3, No. 2, pp. 143-154.

Boehm, B. (2000), 'Unifying Software Engineering and Systems Engineering', *Computer,* pp. 114-116.

Carnegie Mellon University, Software Engineering Institute. Upgrading From SW-CMM to CMMI®.

Carnegie Mellon University (1994), Software Engineering Institute. *The Capability Maturity Model: Guidelines for Improving the Software Process*, Addison Wesley Longman, Inc., Reading, MA.

CMMI Product Team, (2002), *CMMI for System Engineering, Software Engineering, Integrated Product and Process Development, and Supplier Sourcing (Staged Representation)*, Report no. CMU/SEI-2002-TR-012; ESC-TR-2002-012, Pittsburg, PA.

Curtis, P., Phillips, D.M. and Weszka, J. (2002), 'CMMI - The Evolution Continues!', *Systems Engineering,* Vol. 5, No. 1, pp. 7.

Davenport, T.H., Harris, J.G., de Long, D.W. and Jacobson, A.L. (2001), 'Data to Knowledge to Results: Building an Analytic Capability', *California Management Review,* Vol. 43, No. 2.

Day, G. S. (1994), 'The capabilities of market-driven organizations', *Journal of Marketing,* Vol.58. No. 4, pp.37-52.

Dayan, R. (2003), 'KM and Culture Change at Israel Aircraft Industries', *The Knowledge Management Review,* Vol. 6, No. 2, pp. 12-15.

Heisig, P. (2002), *European Guide to Good Practice in Knowledge Management - Frameworks on Knowledge Management*. Fraunhofer IPK.

Jacobs, J.C. and Trienekens, J.J.M. (2002), 'Towards a Metric Based Verification and Validation Maturity Model', *Proceedings of the 10th International Workshop on Software Technology and Engineering Practice (STEP'02),*

Kristensen, K. and Westlund, A.H. (2004), 'Accountable Business Performance Measurement for Sustainable Business Excellence', *Performance Measurement and Business Results,* Vol. 15, No. 5/6, pp. 719-734.

Lepasaar, M. and Makinen, T. 'Integrating Software Process Assessment Models Using a Process Meta-Model', *IEEE,*

Liebowitz, J. and Wright, K. (1999), 'Does Measuring Knowledge Makes "Cents"?', *Expert Systems With Applications,* Vol. 17, pp. 99-103.

Lim, K.K. and Ahmed, P.K. (2000), 'Enabling Knowledge Management: A Measurement Perspective', *ICMIT,* pp. 690-695.

Martin, W.J. (2000), 'Approaches to the Measurement of the Impact of Knowledge Management Programmes', *Journal of Information Science,* Vol. 26, No. 1, pp. 21-27.

Miller, M.J., Pulgar-Vidal, F., and Ferrin, D.M. (2002), 'Achieving Higher Levels of CMMI Maturity Using Simulation', *Proceedings of the 2002 Winter Simulation Conference.*

Paulk, M., Weber, C., Curtis, B., Chrissis, M. B. (1995), *'The Capability Maturity Model'*, Addison Wesley.

Ramanujan, S. and Someswar, K. (2004), 'Comparison of Knowledge Management and CMM/CMMI Implementation', *Journal of American Academy of Business,* Vol. 4, No. 1/2, pp. 271-275.

Rassa, R.C., Garber, V. and Etter, D. (2002), 'Capability Maturity Model Integration (CMMI^SM^): A View From the Sponsors', *Systems Engineering,* Vol. 5, No. 1, pp. 3.

Vernick, J.A., Jackson Purvis M. and Thomas, W.R. (2002), 'The SEI Transition Partner Program for CMMI', *Systems Engineering,* Vol. 5, No. 1, pp. 27.

Zubrow, Dave (2003), 'Current trends in the adoption of the CMMI(R) product suite', *Proceedings of the 27th annual international computer software and applications conference.*

---

[1] CMM, Capability Maturity Model, and Capability Maturity Modeling are registered in the U.S. Patent and Trademark Office.
[2] CMMI is a service mark of Carnegie Mellon University.
[3] KM procedure considered as part of the sharing chapter, as listed in the KM paragraph.
[4] KM procedure considered as part of the capturing chapter, as listed in the KM paragraph.
[5] KM procedure considered as part of the retrieving chapter, as listed in the KM paragraph.
[6] KM procedure considered as part of the capturing chapter, as listed in the KM paragraph.
[7] Compare to the KM measurement as detailed in the KM paragraph.
[8] KM procedure considered as part of the creating chapter, as listed in the KM paragraph.
[9] In the KM program we call them Good Practices that evolve eventually to become Best Practices.
[10] KM procedure considered as part of the capturing chapter, as listed in the KM paragraph.
[11] As mentioned in the KM paragraph.
[12] As mentioned in the KM paragraph.
[13] KM procedure considered as part of the retrieving chapter, as listed in the KM paragraph.
[14] As mentioned in the KM paragraph.