

Why CMMI Maturity Level 5?

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Abstract. Most organizations that use the CMMI® stop their process improvement journey at Maturity Level 3 or less. Yet, the CMMI high maturity processes offer the greatest potential for ROI. This article outlines why the high maturity process areas have the highest ROI potential, and presents data from Raytheon Integrated Defense Systems (IDS), a CMMI Maturity Level 5 organization, as an example.

Introduction

CMMI high maturity levels have always been controversial, highlighted by cost vs. benefit debates, supplier selection, and model interpretation issues. “It costs too much!”, “Where are the benefits?”, “Our customer only wants us to be Level 3!” are typical comments heard. Many organizations decide that Maturity Level 3 is adequate, and choose not to pursue high maturity. Over 90% of organizations submitting appraisal results to SEI are Maturity Level 3 or lower [1]. Lost amidst the rhetoric is why an organization would want to be Maturity Level 5 in the first place. This article demonstrates that Level 5 can be the most cost effective of all the maturity levels. IDS will be used as an example to depict the value, benefits, and impact of implementing CMMI Maturity Level 5 processes.

History and Controversy

High maturity controversy dates back to the CMM® years. When the CMM was released, few prototypes of high maturity organizations existed. The most oft-cited example at the time was the Space Shuttle Onboard Software project at IBM-Houston [2].

The number of CMM high maturity projects increased after the 1999 publication of a memo from the Office of the Undersecretary of Defense (often referred to as “The Gansler Memo”) set an expectation of CMM Maturity Level 3 for software development contractors of ACAT I programs. If CMM Maturity Level 3 was an expectation, then CMM Maturity Level 5 was seen as a key discriminator for winning contracts. This pattern continued with the release of CMMI. If CMM Maturity Level 5 was a discriminator, then CMMI Maturity Level 5 was seen as an even greater discriminator.

Unfortunately, customer satisfaction did not appear to rise in parallel with CMMI high maturity level ratings. Many customers lamented that they were not seeing what they expected as high maturity results on programs from high maturity organizations.

This led to a series of high maturity level-setting clarifications and standards from the SEI. New courseware was developed called “Understanding CMMI High Maturity Concepts.” A Standard CMMI Appraisal Method for Process Improvement (SCAMPI)SM High Maturity lead appraiser certification program was established. Audit criteria for high maturity appraisals were released. Numerous SEI presentations delivered at conferences addressed perceived high maturity misinterpretations, and stressed the importance of the CMMI informative material in understanding and implementing high maturity practices. Fixing high maturity became the impetus behind the November 2010 release of CMMI V1.3.

The Big Picture

Looking at the big picture, it becomes obvious that the high maturity controversy is really a high maturity appraisal controversy. Let us remember that the CMMI was created to support business improvement. As a model containing best practices, the CMMI is a strategic tool used to help achieve business objectives. Those business objectives are expected to be achieved from improved performance, not through the marketing of maturity levels. The CMMI model and its maturity levels are a means to an end, not an end unto themselves.

Any organization using the CMMI to improve business performance can open the model and select related good ideas contained therein regardless of whether those ideas are described in bold font (required and expected material) or normal font (informative material). The “required, expected, or informative” designation of CMMI material only becomes relevant in appraisals. Although CMMI V1.3 restructured some of the material contained in the high maturity process areas, and clarified high maturity related glossary definitions, the essential high maturity concepts remained unchanged from CMMI V1.2. Organizations that took a holistic approach to implementing CMMI V1.2 high maturity will see little change in CMMI V1.3. Organizations that took an appraisal-centric approach to CMMI V1.2 high maturity, focusing solely on required and expected material, are likely to see significant change in CMMI V1.3 high maturity.

The practices described in CMMI Maturity Level 2-5 process areas all offer benefits.

CMMI Maturity Levels 2 and 3 focus on disaster prevention and gaining control of the way work is performed in an organization:

- **Maturity Level 2 processes focus on disaster prevention due to unrealistic plans, lack of requirements management, poor configuration management and quality, management without measures, and ineffective supplier management.**
- **Maturity Level 3 processes focus on increased consistency of performance using common organizational processes tailored by individual programs, and increasingly proactive management techniques.**

CMMI Maturity Levels 4 and 5 offer a much more strategic focus. This focus is built around establishing and managing against quality and process performance objectives that align with business objectives:

- **Maturity Level 4 processes establish quality and process performance objectives that trace directly to business objectives.**

The organization develops a statistical understanding of its ability to perform against the quality and process performance objectives by using process performance baselines and models. The quality and process performance objectives are flowed down to individual programs that manage against those quantitative targets. In this manner, individual programs in the organization recognize their role in business success, and take action accordingly if the objectives are not being met.

Maturity Levels 2 and 3

PMC SG1: Actual project progress and performance are monitored against the project plan.

IPM SP 1.5: Manage the project using the project plan, other plans that affect the project, and the project's defined process.

OPF SP 1.3: Identify improvements to the organization's processes and process assets.

Maturity Levels 4 and 5

OPP SP 1.1: Establish and maintain the organization's quantitative objectives for quality and process performance, which are traceable to business objectives.

QPM SP 2.2: Manage the project using statistical and other quantitative techniques to determine whether or not the project's objectives for quality and process performance will be satisfied.

OPM SG2: Improvements are proactively identified, evaluated using statistical and other quantitative techniques, and selected for deployment based on their contribution to meeting quality and process performance objectives.

Table 1

Raytheon Goals

- Be regarded as a customer focused company.
- Grow revenue faster than market. Build on good performance in improving cash flow. Execute well and with predictability.
- Retain and attract world-class talent while providing superior opportunities for employee development. Treat all employees with respect. Leverage our diversity efforts as a competitive advantage, continuing Raytheon's leadership in diversity.
- Improve ROIC for Raytheon Company. Take R6σ™ to the next level, further engaging customers and partners. Deliver greater value and predictability through IPDS, EVMS, and CMMI®.



Raytheon IDS Engineering Quality and Process Performance Objectives

Cost	Schedule	Quality	People
Cost Performance Index $\geq x$	Schedule Performance Index $\geq x$	Defect Containment $\geq x\%$	Average x Hours Training per Employee
Productivity $x\% > \text{Bid}$	Productivity $x\% > \text{Bid}$	Defect Density $< x$	
Defect Containment $\geq x\%$	On time Deliverables Average $> x\%$	Requirements Volatility $\leq x\%$	
Requirements Volatility $\leq x\%$			

Figure 1

• Maturity Level 5 processes establish a system of continuous evaluation and maintenance of business objectives, and the associated quality and process performance objectives. Progress against those objectives is analyzed, and process improvements are identified based on their contribution towards achieving the objectives. Causal analysis and resolution techniques are used in support of these activities.

Let us compare some example Maturity Level 2 and 3 processes against Maturity Level 4 and 5 processes. See Table 1 [3].

The Maturity Level 2 and 3 processes are all good things to do: having project plans, managing against project plans, and identifying process improvements. Note, however, the Maturity Level 4 and 5 focus on quality and process performance objectives derived from business objectives. Flowing the quality and project performance objectives down to programs, and using quality and process performance objectives as the basis for process improvement activity, is what sets the stage for the greater return on investment than may be realized from Maturity Levels 2 and 3. A business can only be successful if its programs are successful. At Maturity Levels 4 and 5, the entire organization becomes enlisted in helping the business achieve its objectives. Programs have to manage against those objectives, report status to higher-level management regularly, and take actions when the objectives are not being achieved. Programs in turn may establish their own quality and process performance objectives, based on achievement of award fees or other significant results.

Raytheon IDS Engineering Quality and Process Performance Objectives

Raytheon, like many large organizations, annually establishes high-level goals for the company. See Figure 1. The Raytheon goals are business objectives designed to help the company be successful. Within Raytheon IDS, engineering evaluates the Raytheon goals and establishes quality and process performance objectives based on what engineering must accomplish to help the company achieve its goals. As in many organizations, the quality and process performance objectives relate to cost, schedule, quality, and customer satisfaction. See Figure 1. Those objectives are flowed down to programs as performance management targets, and to the organization as process improvement prioritization criteria. In this manner, the entire organization becomes enlisted in a "grass roots" effort to help Raytheon achieve its goals.

Raytheon IDS ROI from CMMI Maturity Level 5

In November 2008, Raytheon IDS was appraised to be CMMI Maturity Level 5 for Systems, Software, and Hardware Engineering. Previously, portions of Engineering had achieved Maturity Level 3 in 2003 and Maturity Level 4 in 2005. In 2009, a CMMI Maturity Level 5 return on investment analysis was performed. The data used in this study compared Raytheon IDS Systems, Software, and Hardware Engineering performance in 2005 versus 2008. Data on cost, schedule, quality, and customer satisfaction were analyzed, and overall ROI determined based on investment and savings.

• Investment was defined as the cost of all activities to incorporate Maturity Level 4 and 5 practices into our processes

and be appraised. This includes development and deployment of updated processes and enablers (e.g., process performance models), training, and all appraisal costs.

- Savings was calculated by applying 2005 baseline rates (e.g., 2005 productivity) against 2008 size (e.g., lines of code) to determine a “projected cost at baseline rates,” and comparing the “projected cost at baseline rates” to 2008 actual costs.

Individual Causal Analysis and Resolution (CAR) and Organizational Innovation and Deployment (OID) improvement activities were examined. CAR and OID activities are process improvements made specifically to help achieve quality and process performance objectives. Examples of these improvements included increasing peer review effectiveness, steps taken to reduce requirements volatility, and deployment of improved software static analysis tools. As noted in Table 2, the overall CAR and OID ROI was 38.4:1. The large ROI is not surprising, given that these activities are focused on achieving quality and process performance objectives related to improving productivity, defect containment, and similar high-yield initiatives.

System, Software, and Hardware Engineering performance improvements on targeted tasks are listed in Table 3.

Raytheon IDS Engineering realized an overall ROI of 24:1 from CMMI Maturity Level 5 activity. The 2006 SEI study “Performance Results of CMMI-Based Process Improvement” [4] showed CMMI ROI ranging from 1.7:1 to 27.7:1, with a median of 4:1. The Raytheon IDS Engineering ROI would place near the top of that scale.

The Raytheon IDS Engineering ROI and performance results are a direct consequence of meaningful process improvement aligned with the business objectives and associated quality and process performance objectives. The high maturity focus on improving processes that have the most impact on achieving those objectives (e.g., productivity, defect containment, requirements volatility), produced results that added value to the business. This is the essence of high maturity.

The high maturity benefits described in this article are based on a Raytheon IDS study performed in 2009. A 2010 follow-on study showed that benefits from CMMI Maturity Level 5 continue to accrue. CMMI Maturity Level 5 remains a cornerstone of the Raytheon IDS business strategy today.

Summary

What an organization gets out of CMMI-based process deployment and appraisals is a function of what the organization puts into it. Organizations that focus on maturity level ratings and CMMI minimal compliance are unlikely to derive benefits from their investment. Organizations that use the high maturity principles to deploy meaningful process improvement aligned with business objectives are organizations that are much more likely to reap greater return from their investment.

Maturity Levels 2 through 5 all offer benefits. Maturity Levels 2 and 3 help prevent disasters and gain control in the way work is performed in an organization. There is no denigrating the improvements an organization can realize from implementing Maturity Level 2 and 3 processes.

	Total ROI	Highest ROI	Lowest ROI	Median ROI	Number of data points
Total CAR/OID ROI	38.4:1	183.3:1	1.9:1	14.3:1	19
ROI on OID Projects	57.1:1	183.3:1	10.7:1	50.8:1	5
ROI on CAR Projects	25.8:1	85.5:1	1.9:1	9.6:1	14

Table 2

Engineering Discipline	Performance Improvement
Systems Engineering	56% Requirements Volatility improvement 14.3% Requirements Development Productivity improvement 4% Cost Performance improvement 63% variance reduction in Cost Performance Index
Software Engineering	65% Design-Code-Test-Integration Productivity improvement 11.6% Defect Containment improvement
Hardware Engineering	25% Mechanical Engineering Productivity improvement 33% Analog Electrical Design Productivity improvement 56% Digital Electrical Design Productivity improvement 65% Drawing Checking Defect Density improvement
All	On time Deliverables > 99% since 2006

Table 3

However, Maturity Levels 2 and 3 are not focused on quality and process performance objectives as the driver of process improvement activity, and therefore set a lower ceiling on the benefits of CMMI-based process improvement. Using Maturity Level 4 and 5 processes to manage against quality and process performance objectives creates a grass roots movement within an organization to meet business objectives. An organization where all individuals recognize their role and responsibility for business success is an organization that is more likely to achieve success. ♦

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REFERENCES

1. SEI. "CMMI for Development SCAMPI Class A Appraisal Results 2010 End-Year Update", SEI, Carnegie Mellon University, March 2011. <<http://www.sei.cmu.edu/cmmi/casestudies/profiles/cmmi.cfm>>
2. SEI. The Capability Maturity Model, Guidelines for Improving the Software Process v1.1. Addison Wesley, 1994.
3. Chrissis, Konrad, Shrum. CMMI for Development V1.3, Guidelines for Process Integration and Product Improvement. Addison Wesley, 2011.
4. Gibson, Goldenson, Kost. "Performance Results of CMMI-Based Process Improvement" CMU/SEI-2006-TR-004, 2006.

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