



# SEI CMM Level 5: Lightning Strikes Twice

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*In December 2001, the Boeing Military Aircraft and Missiles Seattle Site (AMSS) organization (within the former Boeing Military Aircraft and Missiles) achieved a Level 5 rating using the Software Engineering Institute's Capability Maturity Model® (CMM®). This rating was achieved just 12 months after receiving a Level 3 rating in December 2000. While making such a rapid progression from Level 3 to Level 5 is uncommon, it was not unprecedented within Boeing. In 1995-1996, the Boeing Space Transportation Systems organization (within the former Boeing Space and Communications) achieved a Level 3 to Level 5 transition in approximately six months. This article describes three essential factors that were common to both organizations that enabled such a rapid progression from CMM Level 3 to Level 5.*

In the August 2001 "Process Maturity Profile of the Software Community 2001 Mid-Year Update" [1], the Software Engineering Institute (SEI) reported that the median time to move from Capability Maturity Model® (CMM®) Level 3 to Level 4 is 33 months, followed by 18 additional months to reach CMM Level 5. Obviously, accomplishing the same objective in six to 12 months is a remarkable achievement. To do it twice – as two organizations within The Boeing Company did – is not only a credit to the organizations involved, but to the underlying principles that were present in both efforts.

In December 2001, just 12 months after receiving CMM Level 3, the Boeing Military Aircraft and Missiles Seattle Site (AMSS) organization achieved CMM Level 5. Previously in 1996, the Boeing Space Transportation Systems (STS) organization transitioned from CMM Level 3 to Level 5 in approximately six months.

It is not a mystery that any successful improvement effort – regardless of its timeline – requires sponsorship, practitioners' involvement, and a focus on the organization's business needs. But those elements by themselves do not necessarily equate to an accelerated timeline, which begs the question: What additional factors must be present in an organization in order to achieve high-maturity in a relatively short amount of time?

Although the Boeing AMSS and STS achievements<sup>1</sup> were separated by approximately six years and involved different personnel, they shared the following three fundamental elements in their approach to improvement: software engineering process group (SEPG) composition, a strong tie to the business case, and projects that had institutionalized a data-driven approach to management. The following sections will describe each of these

common elements and how they contributed to each organization's success.

## SEPG Composition

Sponsorship is a commonly cited reason for why improvement efforts succeed or fail. Both AMSS and STS addressed the issue of sponsorship by carefully crafting their SEPG. The first common element was SEPG leadership.

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Senior managers (i.e., a manager of other managers) or executive managers (i.e., project managers) were appointed to chair the SEPG and were allowed time to do so as a part of their job descriptions. The STS software engineering manager chaired the STS SEPG with membership that included all project software managers, key leads, key domain experts, and process focal points. For the AMSS SEPG, an executive manager was appointed chairperson, with membership that included the chief software engineers from each project, domain experts, and process focal points. In both cases, managers accounted for 33 percent to 50 percent of total SEPG membership.

In addition, AMSS had a steering committee that included program executives and business unit functional managers. The steering committee's role was

to establish AMSS objectives, commit resources, and monitor the progress of the AMSS SEPG.

Including senior managers and program executives in hands-on roles in the improvement effort was the first key to securing project participation. SEPG leadership activities went beyond declarations of intent, writing policy, and attending weekly meetings. SEPG leaders and members had a stake in the outcome of the improvement efforts because it affected products they had responsibility for producing.

Additional benefits included the following:

- The individuals who were accountable for producing the overall system set the process improvement goals, which aligned improvement efforts with the product and business needs, not a model.
- The individuals who had responsibility for building the software dictated what the processes were and how they should be used. There was a clear relationship between a process and its impact on day-to-day work.
- The managers who had authority over budgets and personnel resources put plans into action. As a result, improvement efforts were an integral part of the mainstream software development activities rather than activities isolated from the business concerns.

Improvement efforts were closely tied to the bottom line; the people making the decisions were accountable for the products being produced by the processes.

Staffing the SEPG in this way established the group with responsibility, authority, and accountability. Oftentimes, SEPGs are staffed with individuals who have the responsibility for managing the improvement effort but have little or no actual authority to change behavior, no personnel or budget authority, and no

direct accountability for cost, schedule, or quality. The key factor that separated the Boeing AMSS and STS organizations was the insistence that SEPG leaders and members have a stake in the outcome that was directly tied to the bottom line of the projects within the organization.

Another common practice on both teams was the commitment to charter the SEPG based on continuous process improvement, not to simply achieve a CMM level. Gary Wigle and George Yamamura described this and other successful practices of the STS SEPG in their 1997 article, "Practices of an SEI CMM Level 5 SEPG" [2]. The position of STS was that chartering an SEPG based on continuous improvement would align the business case for improvement with the activities of process definition, process change management, technology insertion, process evaluation, training, process improvement support, and regular assessments. A SEPG charter based on the business needs of the organization, combined with personnel that have the authority to make changes, were key to the success of STS.

AMSS adopted a similar philosophy early on by selecting the STS charter as its model. This approach to SEPG composition and function provided the foundation for understanding the business case for high maturity practices, and assured that key stakeholders were involved.

This approach has proven successful on two separate occasions in two completely different business units. The fact that the model proved successful in completely different domains, with different personnel involved, and with approximately six years separating the two efforts underscores the value of chartering and staffing an SEPG in this manner.

## A Strong Tie to the Business Case

The second key factor was developing an understanding of what areas were critical to producing successful, high-quality products in order to focus improvement efforts. In the case of STS, the Inertial Upper Stage (IUS) project had a business objective to achieve a 100 percent mission success rate. Over time, they developed a clear understanding of the relationship between key development practices and mission success. Defect prevention was strongly emphasized long before the CMM was ever published because software errors during flight could rapidly lead to mission failure.

For AMSS, the Boeing F-22 project

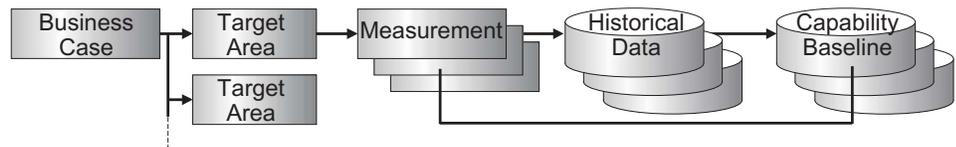


Figure 1: Business Case Driven Approach

had established a history of outstanding product quality, cost, and schedule performance. Maintaining a careful balance of cost, schedule, and quality performance while reducing cycle time has become a primary business objective. Before either organization made an effort to achieve Level 5, the underlying business goals and criteria for success were established and communicated to everyone in the organization. Consequently, processes and metrics were inherently aligned to provide the necessary insight into critical processes and product quality.

As an example, the former Military Aircraft and Missiles Business Unit used five balanced measures in the areas of cost, schedule, quality, cycle time, and inventory/backlog. Four of these five were deemed relevant to software and

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flowed down to the AMSS organization (cost, schedule, quality, and cycle time). At the project level, data supporting these four areas had already been collected and used for a number of years. The data were researched and analyzed to establish historical baseline capabilities for process and quality. This established a quantifiable understanding at the project and organization levels in areas that were already tied to the business case of the organization and the business unit. This also provided a commonality among metrics in use by all projects of the organization (see Figure 1).

In both cases, the pursuit of high maturity practices was rooted in a quantifiable understanding of the impact improvement efforts would have on the

bottom line. In fact, the application of the CMM-based approach had little to do with the CMM itself; rather, it was the act of putting these practices into place that eventually improved the project in terms of cost, schedule, and quality. Most importantly, that understanding was shared with senior managers and executives who were accountable for mission success.

## Project Culture and Historical Data

The existence of historical data that had been consistently collected over several years was the final contributing factor to achieving Level 5 in such a short time. In both cases, the organizations valued a data-driven approach to software management; both had used a consistent set of indicators for a number of years. Each organization had at least one project (IUS for STS, and Boeing F-22 for AMSS) that, through the necessity of meeting business and mission objectives, had long since initiated a data-driven approach to software management.

Making the transition from Level 3 to Level 5 amounted to taking what the managers understood as intuition, experience, and instinct and adding the quantitative understanding as revealed through analysis of the historical data. Managers on both IUS and Boeing F-22 had been making mental quantitative interpretations of the data for a number of years. Providing a historical context based on statistical analysis was a logical extension to the existing mindset of the software managers. Deployment was further accelerated by the fact that a quantitative understanding of process and quality was introduced in areas where data had been collected and analyzed for a number of years. While the presentation and usage of the historical data was new, the practice of collecting, reporting, and acting on the data had been long-since established.

For both organizations, introducing a quantitative understanding of the data in use was treated as an extension of an existing practice, not a new practice. Once this technique was understood and the benefits quantified, the value of applying this practice to other areas of software development became obvious. Each organization prioritized its efforts based

on the data that directly tied to its core business needs. This resulted in a quantitative metric set that included eight to 12 metrics distributed across process and quality.

Both organizations used metrics relating to cost and schedule that included earned value, cost and schedule variance, budget, actuals, and product release performance. STS used several defect-related measurements that ranged from defect removal during peer reviews to defect profiles (quantity and density) for each software product with clear traceability to ongoing defect prevention efforts. AMSS also used defect density measurements but with an increased emphasis on cycle time, and used measurements such as build cycle time to help manage improvements without sacrificing cost or quality.

Using eight to 12 metrics proved to be both meaningful and manageable. Some organizations can fall into the trap of trying to produce more Level 4 metrics than can possibly be used in an effective manner. In addition, new metrics may get invented that provide interesting information, but have no real significance in understanding the things that are vital to running the business. Both AMSS and STS avoided that trap because of SEPG composition and the tie to the business case. The individuals who used the metrics dictated what areas were meaningful.

## Summary

The combination of hands-on participa-

tion by senior managers and executives, a clear tie to the business case, and the availability of mature historical data all contributed to making a rapid and almost intuitive transition to the high maturity practices. A common reaction from achieving Level 5 by both STS and AMSS was that it validated long-standing business practices that had been refined and elevated as best practices. Instead of having to overcome the not-invented-here syndrome, members of each organization were proud to say these processes were invented here. ♦

## References

1. Software Engineering Measurement and Analysis Team. Process Maturity Profile of the Software Community 2001 Mid-Year Update. Pittsburgh: Software Engineering Institute, Carnegie Mellon University. Aug. 2001.
2. Wigle, Gary B., and George Yamamura. "Practices of an SEI CMM Level 5 SEPG." *CrossTalk* Nov. 1997.

## Note

1. Both Space Transportation Systems (STS) and Boeing Military Aircraft and Missiles Seattle Site (AMSS) assessments were conducted using the CMM-Based Appraisal for Internal Process Improvement method with external lead assessors from the Software Engineering Institute, STS, and Q-Labs (AMSS).

## About the Author



**Gregory P. Fulton** is currently the software process improvement lead for Boeing's F-22 program, and Capability Maturity Model®

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