

An Insider's View of CMM Level 5

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Many organizations in the software industry have adopted the Software Engineering Institute's Capability Maturity Model since its inception. Its prevalent use has engendered many advocates and detractors, making CMM adoption—its cost to implement and the benefits reaped from it—a topic of lively discussion. However, only recently have enough organizations reached Level 5 to enable a coherent discussion of Level 5 issues. To facilitate such a discussion, the editors of Quality Time solicited questions about what it means to be a Level 5 organization from academic, industry, and government representatives. I then interviewed Bob Yacobellis, senior director of Process and Quality Excellence for Motorola's Global Software Group (GSG), which provides software development capability for Motorola business units, customers, and suppliers worldwide. It began in late 1990, with the first GSG center opening in Bangalore, India, in 1991. GSG today is a collection of high-maturity software centers, some of which have multiple sites located in 15 countries, including the US. GSG has about 3,000 software people (as of April 2003), nearly 90 percent of whom operate in software organizations running at Software CMM Level 4 or 5 capability.



Q: What are the three greatest difficulties in moving to Level 5?

The three hardest problems that we have seen in moving to Level 5 (primarily in other organizations) are

- The need for commitment from top management, sponsorship, and resource investment. Without these, a process maturity improvement initiative will take much more effort and usually get blocked at Level 3, if it doesn't wither and die. If senior management doesn't understand the business reasons for and their role in driving software improvement, the organization will not achieve Level 5 capability.
- The need to understand the critical transitions in moving through the CMM levels, especially from Level 1 to Level 2 (project discipline) and Level 3 to 4 (management by data and Statistical Process Control discipline). Going from Level 2 to 3 (organizational discipline) and Level 4 to 5 (continuous improvement discipline) seem to be somewhat easier.
- The belief that an organization has "made it" once it reaches a given CMM level and must no longer invest in or pay attention to disciplined, systematic software development and management practices. If an organization believes it has arrived once it reaches a certain level, or if it sees the CMM levels as a checklist (a business goal in itself rather than a means to an end or a toolkit to improve business results), it is easy to slip back to the previous level or even Level 1.

The three major building blocks for getting to Level 5 that we have used in GSG are

- A standard way of doing business that engages management from the very beginning.
- Standard training and hiring practices. When we hire for GSG centers, we tell people up front that we are running a high-maturity software organization and encourage them not to hire on with us if this doesn't fit their expectations. In addition, we put new hires through a standard induction training program, which typically runs about four weeks.
- Continuous improvement based on data. As mentioned earlier, GSG uses standard software and business metrics at all organization levels to assess progress, gauge performance, and drive improvement. Taking metrics is part of the day-to-day for a GSG software engineer or manager, and this data is continuously fed back into defect prevention and ongoing improvement projects at the project, center, region, and GSG levels.

Q: How does your organization do problem-report trend analysis?

We do problem trend analysis at several levels in GSG: project level, center level, region level (for example, Americas, Europe, Asia-Pac), customer level, and organization or enterprise level. At the enterprise level, a set of Software Metrics Summary Charts, which include tracking of in-process faults and post-release defects for all delivered projects, are rolled up on a quarterly basis at the center, region, and GSG levels. We track trends in these and other metrics going back several years to determine how our continuous improvement efforts are affecting our performance as well as which specific centers or projects have excellent results that we can investigate and emulate across GSG. At the project and center level, problems are also tracked using measures such as mean open time, mean time-to-close problems of different severities, and problem open and close rates (this is especially useful during testing).

Q: How do you work with subcontractors and acquiring organizations that are below CMM Level 5, particularly if they feel that they function just fine as they are?

Some acquiring or sourcing organizations have thought that the work we performed carried too much overhead. We used data that we accumulated from 13 years of continuous high-maturity performance to demonstrate that doing things this way actually shortens the time to deliver software, improves software productivity, and reduces the maintenance burden for released software by significant amounts. In addition, we conducted senior executive software briefings with our customer organizations to help them understand how we apply standard business and engineering practices to software to maximize performance. In some cases, we consulted with our customer organizations to help them improve their own internal software practices and achieve better business results in line with short- and long-term goals.

Q: Is creativity stymied in a Level 5 organization?

We have found that creativity, rather than being stymied, is instead channeled into more effective and productive areas

in high-maturity organizations. Rather than every project or organization having to reinvent processes, metrics, and performance enhancers for software (often only based on intuition or the past experience of specific people in the organization), at Level 5, all of these are shared at the enterprise, region, center, and project levels and based on measured improvement. We know what things are most business-critical for us, and we can predict how changes in process, metrics, and tools will impact our performance.

In a Level 5 organization, people use their creativity to optimize the delivered software's design and content, reduce testing cost, find streamlined approaches to producing software that retain and improve key customer satisfiers, reallocate work to increase productivity, and learn about or invent new software design and production approaches. They focus on what the customer wants, rather than spending time fixing defects, inventing processes, or perfecting tasks that are unnecessary in the first place.

Q: What is the return on investment for reaching Level 5?

Many improvements come with achieving higher process maturity, including reaching Software CMM Level 5. One thing should be clear: Attaining Level 5 is not a goal in itself; it is a means for achieving critical business goals. Many of us in the software industry have found that these factors improve with higher software maturity:

- Quality (both in-process and released defect levels)
- Productivity (software delivered per staff month)
- Cycle time (time to market or time to release software)
- Cost (cost of quality, cost of poor quality, and overall development cost)
- On-time delivery
- Accuracy of initial estimations
- Overtime required to produce software
- Software staff morale

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Yacobellis' organization works with GSG and other Motorola business units to improve the way software is done and create a best-in-class approach to software management and improvement based on achieving business goals and creating a competitive advantage based on software. His organization has recently started providing consulting services to outside industry, building on GSG's 13 years of experience. Services range from software seminars for senior executives to strategic business planning involving software to hands-on improvement of software practices. For more information, visit <http://pqeconsulting.motorola.com>.

Even investing 10 to 20 percent of a software organization's staff in areas such as process, quality, and data management yields payoffs of 2–3 to one or more, especially at lower CMM levels.

Q: With such a highly refined process, how do you keep the necessary presence of creativity, innovation, happy accident, and thinking outside the box?

In GSG's case, each center is operated as an independent business unit. Even though all of the centers work collaboratively on customer projects, each of them can work on issues and opportunities that are unique to their local environment, country, set of customers, and business situation. They are encouraged and expected to work with local universities, governments, and industry to find ways to improve the software industry overall. They have a great deal of autonomy within the structure of a common process framework and a common set of enterprise-level business improvement goals on a year-to-year basis.

We use approaches such as Digital Six Sigma to complement the process discipline and systematic, data-based methods captured in the Software CMM. As part of our ongoing defect-prevention activities, all software staffers are encouraged to propose innovative approaches to improving software processes, improving development or production

techniques, and even growing the business. We work closely with our customers to build on their strategies and to even propose new strategies that will leverage both our process and quality strengths as well as domain expertise and skill sets.

Q: What statistical confidence level are you using to predict the faults?

The statistical confidence levels will vary on the basis of data we process and the approach we use to analyze it. For formal peer reviews, such as inspections, we will set upper and lower

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control limits on preparation and meeting reading rates as well as per-phase control limits for faults found per page or line of code or meeting hour. For other, more dynamic fault prediction methods, such as software reliability analysis of testing or post-release data, we will use appropriate confidence limits based on the specific reliability models that are used. In general, we might use 90 to 95 percent confidence intervals for predictions, but this will vary based on many different factors.

Q: What would you do if all you heard from your team was that everything is going great and there are no problems to report?

It all depends on how they report this situation. A Level 5 organization will almost never report this way without having detailed, data-based information to back it up. The organization will use a multitude of metrics to assess what "going great" and "no problems" mean (based on inspections, testing, particular project phase, and so on). Earned value might tell us that things are, in fact, going great because we can see that we are on track to meet both our budgetary and performance goals as the project progresses. If "no problems" is outside the expected statistical control limits (see earlier question), then the team will also report the results of its analysis to determine the specific root causes of the low-problem situation—high prevention investment, very clean requirements from the customer, recently installed new process, or something else.

However, in a lower-maturity organization, especially Level 1, I wouldn't trust the statement, "everything's going great," without data and further analysis. It's too easy in a Level 1 organization to be stuck at 90 percent completion for months at a time, with no real progress and lots of reworking and retesting sapping away the project's resources. ☛

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