Lessons Learned in Attempting to Acheive Software CMM Level 4

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Getting to the Software Engineering Institute's Software Capability Maturity Model® Level 3 may be quite different than getting to Level 4. The forces, dynamics, commitments, and resources may be quite different for Level 3 than for Level 4. This article focuses on those differences and provides valuable lessons learned gathered on an organization that had achieved Level 3 but failed to achieve Level 4.

This article is based on an organization[2] that had achieved Software Capability Maturity Model (CMM) Level 3 and was working toward Level 4 [1]. Table 1 shows the Software Engineering Institute's CMM levels while Table 2 shows the key process areas (KPAs) within each level [2]. In order to be compliant with any level, an organization must be compliant with all KPAs at that level and all lower levels [2].

This author was the software manager and software engineering process group (SEPG) lead on project X when Level 3 was achieved[3]. Later, as SEPG lead at the next higher organizational level, he developed and executed Level 4 and Level 5 processes for project X. The projects in the organizations were geographically dispersed between both coasts and involved in diversified applications.

An organizational standard process (OSP) existed at the corporate level that only had processes for Level 2 and Level 3. The OSP was adapted and tailored to the projects as projects' defined process (PDP). SEPGs existed at various levels, and the corporation had a software-process training program that supported Level 2 and Level 3. All employees engaged in software development were required to take process training appropriate to their software tasks.

Getting to Level 3

While pursuing Level 3 all projects within the organization were committed and cooperated. The corporate SEPG had membership from the organizations' SEPGs and met monthly. The organization's SEPG met weekly and had membership from the projects. The projects' SEPGs meet weekly. The SEPGs coordinated on the OSP and the PDP and ensured that they were applied in a consistent and repeatable fashion across the organization.

Level	Name	Characteristics
5	Optimizing	Continuously improving.
4	Managed	Quantitative control of products and process.
3	Defined	Management and engineering practices defined at the organizational level.
2	Repeatable	Basic project management established.
1	Initial	Ad hoc and often chaotic.

Table 1: *SEI SW CMM*

Project X was required to follow Department of Defense (DoD)-STD-2165A, Standard for Software Development, along with supporting DoD standards, which provide for all processes and artifacts required for Level 2 and many for Level 3.

Processes for all Level 2 and Level 3 KPAs were installed and executed on the projects. Individuals received process training for both levels. Extensive Level 2 and Level 3 artifacts were collected. Several dry run assessments were conducted and supported with various government CMM Software Capability Evaluations for procurements.

The organization achieved Level 3 in 27 months after being awarded the contract for project X, which was never assessed at Level 2. The assessment was a Software Engineering Institute (SEI) CMM-based appraisal for internal process improvement (CBA-IPI). The lead assessor was from an external vendor while the rest of the assessment team was internal.

Not Getting to Level 4

Executive management mandated that the organization achieve Level 4. Unfortunately, while senior management was somewhat committed and cooperative, project X management was not. They stated that Level 3 was good enough, and that they did not sign up for Level 4. Project X personnel were also neither committed, cooperative, or involved except for the project SEPG lead and the project Software Quality Assurance manager. Project X's customer may not have even been aware of the Level 4 efforts.

Funding from the corporation, the organization, and the projects remained the same as for Level 3, which was insufficient for Level 4. Process staff did not increase more than what was provided for Level 3. Both funding and staff should have increased since new processes and training had to be developed and installed on the projects, and standards did not provide for process or artifacts like they did for Level 2 and Level 3.

The corporate SEPG was not involved with Level 4 activities at the time. The corporation did not have processes or training

Table 2: *KPA's of the CMM*

Level	Name	KPAs
5	Optimizing	Defect Prevention, Technology Change Management, Process Change Management.
4	Managed	Quantitative Process Management, Software Quality Management.
3	Defined	Organization Process Focus, Organization Process Definition, Training Program, Integrated Software Management, Software Product Engineering, Inter-group Coordination, Peer Reviews.
2	Repeatable	Requirements Management, Software Project Planning, Software Project Tracking and Oversight, Software Subcontract Management, Software Quality Assurance, Software Configuration Management.

for Level 4 or Level 5. The organization SEPG had membership from the projects' SEPGs, and they coordinated weekly. Level 4 coordination was very difficult between physically separate locations due to new processes being developed and difficulties encountered in their consistent application. Level 4 was not applied in a consistent or repeatable fashion across the organization.

The projects conducted insufficient Level 4 training, which lacked Level 4 corporate training material. The Level 4 and Level 5 training for project X was developed and provided by this author with little cooperation from project personnel. Project personnel were reluctant to attend training sessions. There were other hindrances:

- Software development standards on contract provided for all Level 2 processes and artifacts and many for Level 3, but not for Level 4 or Level 5. Software development standards do not address such things as quantitative analysis and continuous improvement.
- There was limited industry literature on Level 4 and Level 5 and few examples from which to draw.
- The organization conducted only one dry run for the level 4 assessment that surfaced some problems.

Although project X executed all KPA processes and collected extensive Level 2, Level 3 and Level 4 artifacts, the organization failed to achieve Level 4. The assessment performed was a SEI CMM CBA-IPI, with an external lead assessor and the rest of the assessment team internal to the corporation. There were few assessors that had conducted Level 4 and Level 5 assessments at that time. When assessors do not have appropriate experience with specific KPAs, it becomes difficult to arrive at consistent conclusions.

Reasons Level 3 Achieved but not Level 4

Here are some reasons the organization did not achieve Level 4:

- Commitment, funding, and cooperation existed at Level 3, but were not adequate for Level 4.
- Standards on contract provided for processes and artifacts at Level 3 but not for Level 4.
- All were involved with process improvement at Level 3; only SEPG members on project X were involved at Level 4.
- Level 3 was based on business goals, but Level 4 was done for process sake.
- There were many published examples for Level 3 but few for Level 4.
- There were many experienced assessors for Level 3 but not for Level 4.

Additionally Level 4 is a drastic paradigm shift from Level 3, however, this paradigm shift is not always recognized:

- Level 2 and Level 3 activities are common sense "things to do" in order to develop good software. Level 4 goes beyond this and is for organizations that really want to go the extra mile along the road to process improvement [3].
- Level 3 relies on existing software engineering and project management skills; new quantitative and statistical skills must be acquired for Level 4 [4].
- Level 3's main focus is on the organization, while Level 4's main focus is on the projects [4].
- At Level 3 measurements are used to status activities and correct problems. Level 4 requires measurements be quantitatively analyzed and that immediate actions be taken to remedy issues [2].
- Level 3 requires that process capability be institutionalized, while Level 4 requires that it be understood and controlled quantitatively [2].
- Level 3 requires that quality assurance be institutionalized. Level 4 requires that plans for quality goals are established and that progress towards achieving those goals be quantitatively managed [2].

Conclusions

Getting to CMM level 3 can be quite different than achieving Level 4. The forces, commitments, dynamics, and resources can be quite different, meaning possible success at Level 3 and perhaps failure at Level 4. Process improvement only works if everyone is committed, cooperative, and involved; and if proper resources are available, and improvement is based on business goals. Level 4 is a drastic paradigm shift from Level 3. New and additional skills are required at Level 4 (quantitative and statistical). Process improvement is not the sole responsibility of the SEPG. As with all CMM levels, the entire organization needs to be involved. It cannot be accomplished from outside the organization and the projects; it needs to be everyone's responsibility.

References

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3. Florence, Al, Success at SW CMM Level 3 But Not at Level 4, Lessons Learned, 2001 Software technology Conference Proceedings, Salt Lake City, May 2001.
4. Perdue, Jeff, Why is Level 4 So Hard? Washington D.C., Software process Improvement Network, Nov. 2000.

Notes

1. This article is not based on work done at or by MITRE. Any implications in this article should not be associated with MITRE.
2. When used, organizations and projects refer to the process at the organizational level.
3. When project X is used, the reference is only to that one project.

About the Author

Al Florence has worked at many high technology and aerospace companies and is currently at the MITRE Corporation. He has been involved in all phases of the life cycle as a developer and as a manager. He has developed processes for all CMM key process areas at all CMM levels and is a trained evaluator and assessor. He has a bachelor's degree in mathematics and physics from the University of New Mexico and did graduate work in computer science at the University of California in Los Angeles and at the University of Southern California.

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