

Appendix K

A Correlation Study of the CMMSM and the Software Development Performance

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K.1 Introduction

The following article is an attempt to answer the question, “*How did you achieve a level 3 rating?*” I was the Software Engineering Process Group (SEPG) Team Leader from 1992 until the present time. This article is written from my perspective. When you finish reading this article, I hope you realize that achieving Level 3 status is dependent on people. It is not a matter of following a technical formula to achieve success.

K.1.1 Background

From the early 1970s through 1989, all software effort was performed in either the Maintenance Directorate or the Material Management Directorate. In the late 80’s and early 90’s, we and all other Air Logistics Centers experienced several reorganizations. The effect of these reorganizations was to destroy the infrastructure that supported the software maintenance effort.

When we conducted our first software process assessment in September 1991, we were rated as a Level 1 organization. However, the data showed a surprising amount of strength in both Level 2 and Level 3 key process areas in some parts of the organization. It was obvious from the results of the assessment that software organization fragmentation was a significant weakness. However, the concern of the SM-ALC Commander was that we not optimize software at the expense of our overall weapon system support. For this reason, we were directed to not consider consolidation as one of our recommendations. The concept of consolidation was not dead though, and within a couple of months, we were directed to participate in a study to determine how software maintenance should be organized at SM-ALC. The group conducting that study eventually recommended that the fragmented software groups needed to be consolidated. As a result of that study, the SM-ALC Commander in November of 1992 approved the consolidation of all maintenance software organizations into one Division, TIS. In January 1993, SM-ALC/TIS was created. In March 1993, people were transferred into the Division from their previous organizations.

K.2 Setting the Goal

Shortly before official creation of the new software division, the TI Director took the TIS Division Chief, and the Deputy Division Chief with him on a visit to the TIS software division at Ogden Air Logistics Center, Hill AFB, Utah. On the way back home, the TI Director shared the following with the TIS leaders: “*My vision for you is that your division will become the Software Engineering Process Center of Excellence for the Department of Defense!*” He told them to consider how the organization at Hill AFB was progressing and do it better.

Shortly after TIS was officially formed and people were transferred into the organization, the Division Chief directed that all TIS supervisors and SEPG members participate in a 3-day team building session. I think that the Division Chief felt that his team building session had been successful. Many of us, including the SEPG, walked away from that exercise feeling very abused.

Through the SEPG, the Division Chief met with a consultant from SEI. He was advised to have the organization’s leaders develop a written Strategic Plan that would include a statement of their vision, mission, principles, values, goals, objectives, strategies, and targets. The Division Chief then convened the division leadership once each week to establish the Software Engineering Division’s Strategic Plan. While establishing

the written vision and mission statements was not too hard, establishing the principles, values, goals, objectives, strategies, and targets was much more difficult. As more detail was added to the goals, it became obvious that people were not going to continue doing business the same old way. As this realization took place, discussions became more heated, and resistance increased. After a lot of discussion, the Division's goals were captured in print.

Objective 3 of goal Number 1 stated that the division would achieve a CMMSM Level 2 maturity by October 1993. Objective 4 of goal Number 1 indicated that the division would achieve a CMMSM Level 3 maturity by October 1994. The entire TIS management team established reaching Level 2 maturity as the highest priority objective for the division.

It became apparent to the Division Chief as the summer of 1993 wore on that nothing was really happening. Level 2 was an objective, but there was no evidence that any of the supervisors were taking any steps to incorporate Level 2 practices in their day-to-day activities. The common excuse was that they had too many fires they were fighting and were unable to do any "CMMSM things."

During the August to November 1993 time frame, the Division Chief informed all supervisors that their personal performance plans had been rewritten by him. In those plans, they were given the opportunity to establish CMMSM Level 2 practices in their areas of responsibility. To exceed the standards of performance, they were given calendar dates to have certain practices in place. To be fully successful, they were given a second set of dates. June 1994 was the cut off date to be fully successful on all of the performance standards.

As the Division Chief continued to work with the Division leadership, he found a common theme among all of them. I characterize this common theme as follows:

"What does it mean to be level 2? What does it look like? What do supervisors do? What does it mean to 'organize, train, and equip?' Do I want to be a supervisor?" Supervisors literally did not know what to do. They were all working hard, fighting a constant barrage of "fires." On top of all of that, they were being told they had to operate at something called Level 2. Many began to question if they really wanted to continue being supervisors.

K.3 Training

In late August 1993, the Division Chief asked the SEPG to obtain training on all the CMMSM Level 2 key process areas for the Division. At this point in time, the SEPG consisted of 2 people. I was not happy to be given this task as I had what I thought were more important issues upon which to work. This tasking absorbed most of my time for the next 4 months. We did a fly-off between several vendors and settled on Fastrak Training, Inc. as the source of our training.

From September 1993 through July 1994, we trained approximately 100 people in the Division in the areas of requirements management, project management, configuration management, and quality assurance. In retrospect, one group that should have received this training was the first and second level supervisors — but, they did not. As a result, when we involved the supervisors in management reviews later on, they were not prepared to talk the same language as all of those who had been trained in the formal courses. They did not understand what their project managers had been trained to do, or what their own role was.

We did try to train the management by providing one course in project management for supervisors. Every supervisor was required to attend this week long course. Most supervisors did not want to be present. A year later, most supervisors did not remember ever having been in this class. They were not prepared to participate in such a class. Most felt that they had been to all the management courses they needed and they knew everything they needed to know about being a supervisor. A year later, they would be claiming that they needed to have the same training as their project managers had received.

K.4 More Setting the Goal

By January 1994, the Division Chief was not sleeping very well. He realized that as a Division we were not progressing fast enough. He was well aware that McClellan AFB was being considered as a candidate for closure once again. Our Commander had clearly stated that we all needed to take extraordinary measures to change the way we did business if we were going to survive. So, the Division Chief established a project and project leader to help the organization speed up its metamorphosis. The Division Chief also indicated that we were to arrange to have a Software Process Assessment performed in October 1994. He again stated, we are going to become a Level 2 organization and then we are going to become a Level 3 organization. He said that by October 1994, he wanted the organization to be Level 2, a one year slip from the objective stated in the TIS Strategic Plan.

K.5 PMIP

Thus was born a project that we would later name the Process Maturity Implementation Project (or PMIP). The project leader rapidly put together a plan for how he was going to approach this project. The Division Chief had indicated that the project leader was to work with the SEPG in accomplishing his project. As the leader of the SEPG, I was very irritated that the Division Chief had established a separate project and named a project leader that did not have any training in process improvement work. I really did not want to work with the project leader. It seemed to me that the Division Chief was showing utter disregard for the SEPG. I had tried many times to obtain additional members for the SEPG so we could more effectively help the organization, but every time, the Division Chief had failed to provide the requested help. By creating the PMIP project he had put additional resources on the task and then taken the process improvement effort away from the SEPG. It was also distressing to observe the project leader and realize that both he and the Division Chief were continuing to act in a Level 1 way while they were telling the organization that they must become Level 2.

At this point I had to make some personal decisions about how I was going to act. I began to realize that maybe I could turn this situation into an advantage in order to achieve what we had originally been commissioned to do. I recognized that I was a flaming introvert. I watched the project leader and realized that he was acting much more like an extrovert. So I decided to work with the project leader. I supported him in going out and doing all of the interfacing with masses of people in the organization. On the other hand, I knew some things we needed to do in order to get to Level 2. We eventually worked things out between us that I would do much of the behind the scenes work and he would do much of the visible effort. He also provided another benefit. He acted as a buffer between the Division Chief and the SEPG. I could discuss ideas with the project leader and when he understood them, he could then introduce them to the Division Chief. Through this process and over a period of time, the credibility of the SEPG increased.

As time went on, the project leader and I established a good working relationship. I put aside my irritation and tried to use the situation to the best advantage for the organization. The project leader had an impossible task given to him, but he, and the organization were successful in achieving even more than they had set out to accomplish. After this, several things began to happen in parallel. I will discuss them one at a time.

K.5.1 Practitioner Involvement

The project leader established project leader councils. Each council consisted of representatives from specific sub-organizations and they were tasked to produce a set of strawman or template work products that could be used as starting points for each project. These strawman work products consisted of things like the software development plan (SDP). Strawman work products were produced to satisfy every key process in each of the Level 2 key process areas. All of the project leaders and practitioners in TIS are to be commended for the efforts they made that contributed to the overall effort to achieve Level 2. Every one of them took these tasks on themselves on top of heavy project work loads and pressures from their customers. In addition to the effort required to develop the strawman work products, they also then turned around and instantiated those work products for their own projects. This process of involving practitioners in these councils resulted in the following benefits for the organization:

1. Cross pollination and sharing of ideas was fostered.
2. Communication between practitioners in different Flights was fostered.
3. Documented strawman work products were obtained.
4. The documented strawman work products became a starting point for project leaders to develop final work products. This resulted in more commonality in similar work products and reduced total time spent across the Division in developing the work products.
5. An archive of strawman work products was created.

K.5.2 Supervisor Responsibilities

In the April 1994 time frame, the Division Chief indicated to me that after a number of meetings throughout the Division, he was convinced that the supervisors did not know what they should be doing under the CMMSM practices we were telling everyone they had to follow. He asked if I could prepare something that would describe what the supervisors needed to do to satisfy the CMM.SM In retrospect, this was a turning point in our efforts to start a cultural change in our organization.

I extracted all of the supervisor responsibilities from the CMMSM and put them in a separate document. I produced a matrix that indicated each of their responsibilities and how often they needed to perform that responsibility. In this document, we began to lay the foundation for one of the key supervisor responsibilities: having regular formalized reviews of all of their projects.

K.5.3 Establishing Organizational Policy

One of the responsibilities that appeared on the supervisor's list required them to establish organizational policy. After several weeks, it became apparent that they were never going to have the time to do this and they also did not know what they needed to put into the policy. At this point I had to give up another principle I thought I had learned from the SEI in our early SEPG training. My understanding was that the SEPG was supposed to encourage others to do things. All we were supposed to do was stand by and

provide consulting services when asked. I got fed up with that mode of operation — it didn't work in our environment. I knew I could write the necessary policy, and I finally volunteered to write the first policy.

I wrote the policy for project tracking and oversight very cautiously, very much aware of the resistance in the organization. When the policy was provided to the supervisors, we agreed that they would have one week to review it. After one week, I was to take all comments received and make any necessary revisions. The revised policy was to be given to the Division Chief to review and provide me his requested changes. I would then incorporate his changes, give him a final copy to sign, and then provide copies to the Flight Chiefs in their next staff meeting.

During the development of these policies, the supervisors were very concerned about how changes could be proposed and made to the policies. It became apparent that we needed a formal way to control the configuration of these documents. We therefore established a Division Software Configuration Control Board, with part of its responsibility to control changes to Division policy.

It was during this period that stress levels began to increase tremendously. People were very obviously on edge and, as a Division, I am sure we helped support a number of doctors with stress related illnesses and symptoms. Others decided that they had enough for one lifetime and prepared to retire as soon as they could.

K.5.4 Management Reviews

As supervisors were told their role was to organize, train, and equip, they became increasingly restless. They wondered what their role really was. They felt that they were being told that they could no longer do that which they had the most experience doing: working on technical projects.

One identified supervisor responsibility included in our policies required them to hold regular management reviews of all projects in their organization. Many were unclear about why that was important and did not know what to review. We produced a simple graphic that showed three boxes arranged in a triangle. One of the boxes was labeled "*Project Leader Activities.*" Another was labeled "*SQA Audits*" and the last one was labeled "*Management Reviews.*" We explained that there were three key elements that had to be functioning for the organization to be able to achieve Level 2 status. Each of the three, as represented on the diagram, had to function: they were checks and balances on each other. We explained that the supervisors had a key role to play in helping the organization mature.

Once the supervisors began to accept the idea that they had an important role to play, they were open to suggestions about what they should review during a management review. The Division Chief provided them an outline of what he wanted to see when a project came to him with a project review briefing. With that outline, the first and second level supervisors had a starting point to tailor their review requirements with project leaders.

To make sure that reviews were taking place, the PMIP team collected metrics data on management reviews and provided this data to the Division Chief at his weekly staff meetings. The constant review of this metric made it obvious when supervisors were not holding reviews with their project leaders. This visibility soon resulted in all managers holding reviews.

Another way to ensure that adequate reviews were taking place, required that each review be documented with minutes and that those minutes be archived in the project folder. During SQA process audits, the auditors looked for review minutes. If they were not present, the project received a deficiency write-up that had to be resolved.

Two important things resulted from the requirement that supervisors hold project reviews. First, supervisors felt a renewed sense of their importance and involvement in what was going on in their organization. Instead of having to always fight fires, this process began to give supervisors the tools to prevent fires from happening. Second, project leaders began to feel like someone really cared and was listening to what was going on in their project. They no longer felt they were struggling with their problems alone.

K.5.6 SQA Process Auditing

We started advocating SQA process auditing as early as February 1994, but it took time for the concept to mature. In March 1994 we began developing the criteria the SQA auditors would be using to actually perform their audits.

Several problems plagued us. First, we had only one person designated for SQA. Second, we had very little support from supervisors or project leaders to actually perform process audits. The Division Chief generally supported the concept, but he wanted it to start immediately. No one was prepared to start doing any audits immediately. One individual who was providing on-the-job training to our division had experience in the SQA area and he helped develop a set of detailed process audit criteria for Level 2.

The responsibility “*triangle*” that we used to show supervisors the importance of their function also pointed out the importance of SQA Process Auditing to our goal of achieving level 2. Once supervisors began to understand that concept, we began to obtain their support for performing the audits. With emerging support for the audit concept, the Division Chief asked each of the software Flight Chiefs to provide one individual to augment existing SQA resources to perform the process audits. This solved the resource problem.

The audit team started by just reviewing the criteria for doing project tracking and oversight. It took 3-4 weeks to complete all of the audits. In the process, we found things did not work well and improved the process as necessary. We also were confronted with lots of data, little of it consistent between audit teams, so we held training sessions with the audit teams to improve consistency.

Following this first round of audits, the auditors started a second round in which they looked at the requirements management and project planning key process areas. After that round was completed, a third round was started in which they audited all 6 key process areas at Level 2. As the second round of audits came to an end, the Division Chief requested that all deficiencies for each project be tracked daily to see that these deficiencies were being corrected. This daily reporting soon encouraged all audited projects to clean up their act. The Division Chief received daily status reports on the deficiencies. On the 17th of October, the day the formal process assessment started, the Division Chief had in his possession a set of charts that showed that on the average, the projects being examined by the assessment (23 projects total) were about 96% fully compliant with the CMMSM practices for each key process area at level 2. This data was not made available to the assessment team.

K.6 Summary

A key factor in achieving a Level 3 rating was the commitment at the top of the organization to do whatever was necessary to accomplish it. While focusing our energies on establishing the infrastructure to support Level 2 practices, the Level 3 efforts already ongoing were not neglected. Without the drive of the Division Chief and the PMIP project leader, and the support of the TI Director along with the SM-ALC Vice Commander and Commander, the efforts described above would have been futile. All of these individuals took considerable personal risk in pushing the process improvement effort.

The SQA process audits played a crucial role in helping the organization to progress. Without the audits and the deficiency tracking process, we would have had no insight into whether TIS policies were being applied and followed throughout the Division.

The Supervisors role was also crucial. By holding regular project reviews, they indicated that they were interested in what was going on in individual projects and that they would do their part to improve our processes.

The SEPG played a crucial role in providing knowledgeable guidance where needed. This guidance was often behind the scenes. The SEPG was instrumental in writing TIS policy and in stimulating process auditing and project reviews.

The most important part of this complex process of maturing an organization is the individual people within the organization. If all of the people that make up this Division had not done their best and worked well beyond normal requirements, we could not have achieved a Level 2 or 3 status. So each and every member of TIS deserves credit for what has been accomplished.

Finally, it should be understood that what we have been through is extremely stressful. That stress level continued to rise right up to the assessment. Some people could not sleep well. Others got ulcers. Some probably gained or lost weight. The improvement effort almost ground to a halt. At that point, the pressure to change was relaxed and we began to tell the organization how much they had accomplished. That helped everyone's morale to improve.

K.7 About The Author

Tom Westaway is a member of the Engineering Test Branch of the Software Engineering Division at the Sacramento Air Logistics Center (SM-ALC/TIST). Tom is currently the team leader for the Software Engineering Process Group (SEPG) and has been part of the SEPG since its creation in March 1991. He was on the assessment team during the first assessment at SM-ALC in September 1991. Tom was also part of the team that created a documented software maintenance process known at SM-ALC as the Post-Deployment Software Support (PDSS) Process. For the first few years after he came to SM-ALC, he worked as a system engineer helping to prepare the Logistics Center to support MILSTAR and other satellite systems.

Prior to joining the SM-ALC team in 1981, Tom spent about 17 years working at what was known as the Naval Weapons Center (now Naval Air Warfare Center, Weapons Division), China Lake, California. While at China Lake, Tom helped develop several radar systems and signal processing systems. During this effort, he was awarded 3 patent holding awards for some of his work. It was during these years at China Lake that he learned the value of planning, understanding processes, and project management. These are principles that he has been advocating since coming to work for the Air Force.

Tom Westaway
SM-ALC/TIST
McClellan AFB, CA 95652-
Voice: 916-643-2920 DSN 633-2920
FAX: 916-643-6292 DSN 633-6292
E-mail: westaway.thomas@sma1.mcclellan.af.mil