

Lessons Learned in Using Agile Methods for Process Improvement

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This article presents lessons learned from a process improvement (PI) effort that took an organization from no formal process capability to the implementation of the Software Engineering Institute (SEI) Capability Maturity Model Integration (CMMI®) using the continuous representation with a focus on the staged representation's Maturity Level 2 (ML2) process areas (PAs). This article summarizes techniques that were used to reduce the overall time to achieve institutionalization of new processes as well as what worked and what could be further improved.

When an organization decides to newly embark on PI, there are several issues that influence the amount of effort involved and the effective timeline to achieve a particular PI goal. Lessons gleaned from the software development world in the use of incremental or iterative approaches can be applied to any type of project to achieve similar results, including PI. With proper planning, the end goal can be reached in a greatly accelerated fashion. Effective planning is not the only element, however, that should be considered when reducing duration or budget.

This article examines the approach taken at MORI Associates on a PI effort that not only met its goals but exceeded the expectations of all involved. With about 75 employees spread across seven projects, MORI provides information technology, engineering, and operations services for government agencies and private industry. Included herein are some of the techniques employed and lessons learned along the way.

Be Prepared to Make a Significant Commitment

Before we examine methods to reduce effort and duration, we should discuss the costs and impact involved in a PI effort. Depending on the amount of new processes involved, there can be a considerable amount of effort required on the part of management, project staff, and the overall organization. This commitment will start with the PI effort planning stage, increase substantially as the projects implement new processes, and produce new and potentially large and unexpected work products (e.g., requirements documents and requirements traceability matrices) and will continue even after the appraisal as these processes become part of the new way of doing business.

At MORI, the organization was fully committed to the change process. This commitment began at the top with the sponsor, President/Chief Executive Office of MORI, Shahnaz Deldjoubar, and continued through upper management and out to the staff. The sponsor had all projects perform an in-depth analysis of the impact to effort, resources, and schedule. Their highest priority was their established commitments to their customers in terms of agreed-upon deliveries, services, and schedules. The projects were able to update their plans to implement the new

processes without impacting their customer commitments. Along the way, the staff also contributed some of their personal time, such as conducting software engineering process group (SEPG) meetings during lunch and attending after-hours training sessions. The areas that involved the greatest effort were requirements documentation and traceability, configuration management, and project planning and monitoring.

A summary of the effort involved for process development is shown in Table 1, while the impact felt after process rollout is shown in Table 2.

Table 1: *Process Development Effort*

Activity	Responsible Party	Effort Hours
Develop Processes, Policies, and Work Product Templates	Consultant	647
Meetings, Process Changes, and SEPG Bootstrap	Consultant	186
Review, Approve, and Revise Process Assets	SEPG, Steering Committee, Sponsor	404
Total		1237

Table 2: *Process Implementation Effort for Projects and Organization*

Activity	Responsible Party	Effort Hours
Training and Mentoring	Consultant	167
Training and Mentoring	Organization	251
Implement New Project-Specific Processes (38 work products)	Projects	724*
Implement New Organizational Processes (8 work products)	SEPG, Steering Committee, Sponsor	54

* CMMI is registered in the U.S. Patent and Trademark Office by Carnegie Mellon University.

* Effort represents average per project over a nine-month window for maintaining Web-enabled Management Information Systems.

In comparing this consultant-centric and Agile-based approach to what is expected by an established CMMI estimation model, it is 30 percent more efficient than the most optimistic CMMI process development estimate [1, 2].

Outsource Process Development to Reduce Impacts to Staff

Enlisting a consultant to develop your process assets can be helpful when the capability or PI experience is lacking or the staff is too busy to devote the time needed to develop process assets. At MORI, all process assets were developed by an external consultant with each PA requiring an average of 80 consulting hours to develop, including 77 hours to plan the effort. Consulting time was divided among process development (65 percent); mentoring and training (16.5 percent); and meetings, action items and PIs (18.5 percent). With only a 65 percent availability to develop processes, a four-month calendar (assuming 159 man hours per calendar month) effort required about six months. In the absence of a full-time consultant, companies might assign one or more persons to each PA. Assuming a staff of seven (i.e., one person per PA) and a 20 percent availability (eight hours per week), it should take about three months to develop all the processes. However, most staff assigned to process development tend to be pulled off to perform their normal responsibilities. Availability usually shrinks to 5 percent (two hours per week) and sometimes to zero for extended lengths of time. At 5 percent, process development with a staff of seven can stretch from three months to as many as 12 months or more. With a consultant, the process development schedule can become more deterministic and the staff can stay focused on their projects and the new effort involved. At MORI, the five-person SEPG committed about 8 percent of their time in support of the process development effort and the percentage of time rises to about 13 percent when you include training and mentoring activities.

Run the CMMI Effort as an Agile Project and Use It to Pilot Key Concepts and Tools

Regardless of who is developing the process assets, start prototyping processes from the very beginning by treating the CMMI effort as a pilot project, experimenting with processes that can be adapted and eventually transitioned to the organization.

Our PI effort planned on implementing an incremental development model but ended up implementing an incremental/iterative model. The process development sequence was planned to ensure that long lead items would be kicked off first (in our case documenting requirements and creating a requirements traceability matrix for each project) followed in importance by what seemed like a logical order based on a typical development life cycle. The approach used the continuous representation of the CMMI model. We chose a target profile of the staged representation's ML2 PAs at Capability Level 3 (CL3), Decision Analysis and Resolution (DAR) at CL3, and Organizational Process Definition (OPD) and Organizational Process Focus (OPF) at CL1. We also created a template to document project requirements

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for the Requirements Development (RD) PA. Supplier Agreement Management was deemed not applicable (N/A) and confirmed by our lead appraiser. Although a continuous representation was chosen to execute the PI project, the actual goal was to achieve a staged representation ML2 rating.

The planned order of process development was the following:

1. OPD, OPF, DAR.
2. Requirements Management (REQM) + Requirements Template.
3. Project Planning (PP).
4. Project Monitoring and Control (PMC).
5. Configuration Management (CM).
6. Process and Product Quality Assurance (PPQA).
7. Measurements and Analysis (MA).

Although this order was generally followed, some of the processes and associated work products were actually created and released in an iterative manner while others were developed out of cycle, as some portions of their policies and work products were prototyped for use by the SEPG, followed by pilots on select projects and further iterated on as feedback was generated.

In running the effort as a project, reports on project progress, risks, and issues should be made to the organization's upper management, including the sponsor, on a periodic basis. In our case, a monthly project management review (PMR) was implemented and a PMR slides template was developed. The PMR slides template was developed in an iterative fashion, as the effort progressed. Kicking off the PMR process with monthly reviews of the PI effort helps accomplish quite a few objectives. It communicates progress to the sponsor while planting the seeds of the new PMR process, familiarizing them with the format, and creating a more formal review process. Having the project leaders participate early on allows them to learn by example, even before the process has been documented.

Pilot Key Processes in an SEPG

Use the SEPG to prototype several of the high return on investment (ROI) processes and templates.

Prototype an action item management process and action item log template (PMC), create a process change management process and process change request (PCR) forms (OPF), define process standards (OPD), and define meeting agendas and minutes (PMC) which can be applied to many types of meetings. Once the SEPG processes have stabilized, tailor the process change management process and templates to suit the REQM and CM change control processes. Tailor the meeting agenda and minutes template to use for project staff and customer meetings, for the software configuration control board (CCB) and the requirements CCB. Define metrics to track project and SEPG activity. Discuss and track schedule progress and issues with the SEPG. Reuse these metrics to track project effort, schedule, and activities.

In our case, the project leads were so excited about having certain tools, especially an electronic way to track and manage action items, they piloted them without being asked, adapting them to suit their own needs well in advance of the

development of the associated work product templates. Their early adoption efforts helped identify issues and greatly reduced the PI effort duration and risk.

When asked for a list of the employees' most useful/important new tools and processes, the following is the feedback we received:

- Action Item Log.
- Weekly Status Meetings.
- PMR.
- Schedule Tracking.
- Change Control.
- Metrics and the project measurement repository.

Identify and Implement High-Impact Technology Improvements

During PI planning, determine if there are PAs that could benefit from the acquisition and integration of third-party support products to streamline what otherwise might be manually intensive processes. MORI decided to focus on acquiring tools to automate CM and defect tracking in the near term and possibly address requirements management in the long term.

To facilitate the acquisition process, develop and roll out a high-quality DAR process to the SEPG. MORI used a DAR process using an agreed upon set of evaluation criteria to acquire a freeware CM tool. Although the product review and selection process was detailed, thorough, and extensive, there were some unexpected issues that arose after the tool was installed.

Employ prototyping or simulation techniques when evaluating these critical products. Several issues with the CM system could have been avoided if we had, for example, prototyped check-in and check-out procedures for each candidate CM system solution. When we experienced these types of issues, we updated the DAR process (through a process change request and the SEPG) to identify more precise product evaluation criteria and incorporate simulation and prototyping as a requirement when selecting similar products. This lesson learned was then applied to the evaluation of the defect tracking system where simulation of the change state model was applied to the candidate products.

Leverage the Internet for Process Development Information

Leverage the resources of the Internet to

survey current industry for examples of policies, processes, work products, tools, and lessons learned. It is possible to benefit from the works of established processes, but approach with caution as not all examples will necessarily fit your organization. At MORI, the Internet was used to research example policies; earned value management, risk management, and example DAR processes; lessons learned templates; change request forms; configuration identification and naming conventions; and baseline tagging techniques.

Leverage Industry Standards

Use industry-accepted standards for documentation instead of creating your own. MORI purchased the Institute of Electrical and Electronics Engineers (IEEE) Software Engineering Collection

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[3]. The value of documentation standards such as those produced by the IEEE is that they are a result of the collaboration of many leading industry experts. By using such standards, you are leveraging a larger pool of expertise rather than trying to come up with an internally produced standard, resulting in considerable savings.

Implement Defined Processes

Develop organizational standard processes (i.e. define critical processes at a CL3 level of detail) and tools that include tailoring guidelines instead of flowing down detailed process decisions to each project, as is the case for an ML2 organization (under the staged CMMI approach). This frees projects to do their work with-

out being encumbered with the need to become process experts, especially if they lack the capability to develop their own detailed processes, as is the case with many organizations just starting down the road of PI. Providing detailed PA process descriptions and procedures as well as standard forms, templates, and infrastructure (e.g. common project repository folder structure, CM library, and defect tracking tools) makes the job of project participants and upper management easier, especially when moving from project to project. It speeds institutionalization and simplifies the appraisal process. Processes were documented from the union of the classic IBM ETVX (entry, task, verification, exit) and Watts Humphrey's ETXM (entry, task, exit, measure) process architectures to yield an ETVXM (entry, task, verification, exit, measure) process architecture, where both measures and verification steps augment the description of the entry and exit criteria and tasks to be performed [4]. If going for CL3, remember to add explicit tailoring instructions to fully satisfy Generic Practice (GP) 3.1 and ensure the organization collects best practice examples for its process asset library.

Be CMMI Friendly

Make some of your processes and work products CMMI friendly and, hence, appraisal-friendly; show how they map to each PA. For example, in meeting agendas and minutes, create subsections for each PA. This will help guide important discussions while providing quite a bit of indirect evidence across several PAs. To simplify the appraisal, create project summary presentations that show how each PA is satisfied. Although the Standard CMMI Appraisal Method for Process Improvement (SCAMPI) Method Definition Document suggests creating presentations as a way to increase appraisal related oral affirmations [5], providing direct mappings to each PA within the presentation helps simplify the job of the appraisal team when it comes to the verification of objective evidence (of oral affirmations).

Outsource QA, Ensure Your Designated QA Lead Is Objective, and Keep QA Checklists Simple

An area that is often a challenge for most organizations new to process is QA. As Juran has noted, while companies are generally experts in their particular discipline such as product development, they

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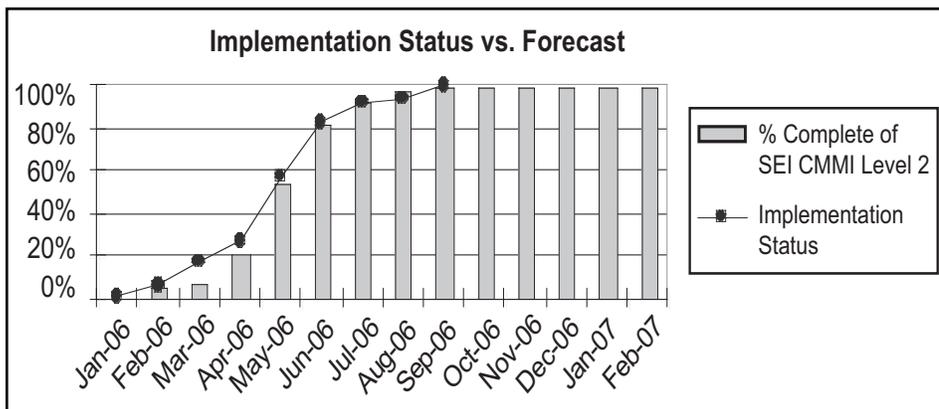


Figure 1: MORI Associates' Process and CMMI Forecast and Compliance Profile

“lack expertise in the ‘quality disciplines’ – the methodology, skills, and tools required to plan for quality” [6]. PPQA is a PA that is more open ended in terms of the details of its specific practices. Many companies find it a challenge to implement, and it is often found to be a weakness during appraisals. Common issues uncovered are that QA training is not properly addressed, that audits are not performed until right before the appraisal and thus not institutionalized, objectivity is not achieved, and audits of the audits are overlooked (i.e. GP2.9 for PPQA is not covered). This is typically the case for organizations lacking dedicated QA resources.

There are some short-term solutions: Assign an acting QA lead, distribute the audit responsibilities across the company, and consider outsourcing some of the audits. However, be careful about outsourcing QA. MORI learned that if QA audits are outsourced and the QA lead is not totally independent of the projects, it is necessary to have the consultant check back to ensure issues were addressed properly and in the appropriate time-frame. Also, make sure QA auditors are trained in the processes and work products they audit.

Create the Practice Implementation Indicator Database (PIID) Early and Get It Validated By a Competent Lead Appraiser

Create the PIID early and use it to track

implementation status as you roll out the processes. Use a high quality lead appraiser to perform a gap analysis of the processes and validate the PIID mappings. Interpreting the model in the context of

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many different approaches is a continual challenge. It is best to have an experienced set of eyes looking at the PIID.

Forecast and Track CMMI Compliance for the Life of Each Project and the Organization

Forecasting process implementation helps an organization track its progress and assess its appraisal readiness. As part of the sponsor’s request to evaluate the

impacts to projects, the project leads worked with the PI consultant to negotiate the projected completion dates of each of the work products associated with the new processes. Using a simple spreadsheet-based tool, the projects and the organization were able to tie the compliance status of each of the specific and generic practices of each PA to the expected and actual completion dates of their associated work products. By initializing the tool with expected work product completion dates, monthly compliance goals were automatically generated.

This tool effectively creates a hybrid PIID that not only reports CMMI compliance but also allows projects to track the monthly status of the direct and indirect artifacts needed to satisfy the PA specific and generic practices. This hybrid PIID uses the work product status data entered in by the project leads to calculate a percentage of compliance for each PA and allows the project leads and organization to determine if they are meeting the planned forecast and still on track to achieve the overall PI effort as planned. This tool also generates an expected appraisal-readiness date for the PI effort and can be used as an input to revise the PI plan and schedule.

A good way to visualize this is through an example. Let us say that a specific practice requires four distinct work products to be generated in order for the practice to be fully implemented and therefore compliant with the CMMI. Let us also assume that each work product takes a month to create and is to be created in a serial fashion. The forecasted compliance trend would then be 25 percent, 50 percent, 75 percent, and 100 percent across this four month time period. One could then collect the actual status of each of these work products from each project as it progresses and average their statuses each month to visualize the organization’s progress toward full compliance for the practice. For long-lead work products, such as the requirements traceability matrix (RTM), status tracking could be made more granular by reporting progress at the product component level, for example.

The overall forecast defines expected monthly process implementation goals for each PA (in terms of work product completion) and predicts the overall target date to reach full compliance with the CMMI model. This self-assessment also helps meet the requirements of OPF SP 1.2.

The forecast and achievement profile for process and CMMI compliance across the MORI organization is shown

Table 3: Compliance of PAs Leading Up to Appraisal – Work Product Completion Perspective

Process Areas	June 2006	July 2006	August 2006	September 2006
REQM	94%	98%	98%	100%
PP	97%	98%	100%	100%
PMC	93%	95%	96%	100%
CM	73%	84%	88%	100%
PPQA	75%	80%	84%	100%
MA	66%	96%	96%	100%

in Figure 1. The bars represent the forecasted process implementation (i.e. percentage of full CMMI ML2 compliance using the staged representation) goals for each month as a cumulative quantity, while the line graph shows the actual compliance achieved.

Figure 1 shows the early gains made from prototyping some of the processes and tools in the SEPG and then piloting tailored versions to the projects. It also shows a slight dip in August as the organization played catch-up on their QA audits (by outsourcing); otherwise, the PI effort was executed according to the plan.

While it was not technically and fully compliant until September, it had achieved a high degree of institutionalization well in advance since the majority of many of the PA's had already been up and running for quite some time (the first process was rolled out in February). This is a major benefit derived from implementing an incremental and iterative approach.

The compliance profile from the PA perspective is shown in Table 3. By June (four months before the actual appraisal), a large percentage of each PA had been implemented. The percentages were based not only on whether a particular process was being performed but on the coverage of work products completed as well. For example, complete credit was not claimed for REQM SP 1.4 until the RTM was completed. The appraiser's perspective is similar but not as rigid. Appraisers want to ensure that processes and work products meet the intent of the model, and they want to see *sufficient* evidence that the processes are being followed. So, for example, an RTM in the process of development with substantial progress made is acceptable and practical. The reason we chose a different interpretation was to drive the projects toward completing their work products. As a result, one project was able to complete its RTM by the appraisal, while the others had made significant progress toward completing theirs. In the end, all were able to claim full credit for their RTM.

From the trends in Table 3, one might expect weaknesses in PPQA and CM since they lagged the other PA's in reaching comparable compliance levels. They were among the last three processes to be rolled out. The appraisal did note a weakness in PPQA, but none in CM.

Although the original schedule called for a February 2007 appraisal, the Lead Appraiser felt that MORI had already

achieved a high state of readiness much sooner. MORI achieved ML2 (staged representation) on October 4, 2006, in nine months with six global and several PA's strengths with only two weaknesses. This result further reflects how a commitment to quality and continuous improvement combined with a more agile approach can help you reach your improvement goals in dramatic fashion.

Summary

As a result of this PI effort, MORI learned many lessons that spanned the entire PI life cycle. Creating a streamlined PI effort is definitely possible when you follow a more agile approach. Implementing an incremental/iterative approach, piloting prototypes to the organization early and often, leveraging industry standards and examples, and identifying and using metrics to monitor and adjust the plan and schedule as needed are all ways to develop processes in a highly responsive manner. Reducing the overall impact to the organization is possible when you outsource process development, implement well defined processes, and provide the right mix of training,

mentoring, and bootstrap services. Using an agile approach can yield significant and even unexpected results over more traditional methods. ♦

References

1. Rico, David F. "How to Estimate ROI for Inspections, PSPSM, TSPSM, SW-CMM, ISO 9000, CMMI." Software Tech News 5.4 (2002) <www.softwaretechnews.com/stn5-4/inspections.html>.
2. Rico, David F. "Capability Maturity Model Integration – CMMI Cost Model." David Rico 2001 <http://davidfrico.com/cmmi.pdf>.
3. IEEE. IEEE Software Engineering Collection. IEEE, 2003 <www.ieee.org/>.
4. Humphrey, Watts S. Managing the Software Process. Addison Wesley, 1990.
5. SCAMPI Upgrade Team. Standard CMMI Appraisal Method for Process Improvement A, Version 1.2: Method Definition Document. SEI, Carnegie Mellon University, 2006.
6. Juran, J.M. Juran on Quality by Design. Free Press, 1992.

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