Applying Lessons Learned from Software Process Assessments to ABET Accreditation

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Abstract - The Software Engineering Institute Capability Maturity Model (CMM) has been widely utilized in the software development community as a means of assessing the maturity of a software development organization and providing a framework for improvement. ABET 2000 is also now being utilized as a means for assessing engineering education programs and providing a framework for improvement. In addition to sharing the same general objectives of assessment and process improvement there are other similarities in both approaches and their application within organizations and universities respectively. Due to these similarities academic organizations embarking on ABET accreditation activities can learn from the numerous lessons from organizations which have undergone CMM activities. This approach was followed at Arizona State University. Since several ASU faculty have been heavily involved in CMM activities over the last decade, it was easy for them to recognize the similarities between accreditation and CMM assessment. They utilized their knowledge of lessons learned from CMM assessments and integrated them into the ASU accreditation effort. The results of this activity are described in this paper.

The paper begins with a discussion of the similarities of CMM and ABET. Both technical and nontechnical similarities such as the impact of employee / faculty buy-in and management / administrative support will be addressed. A review of lessons learned from organizations engaging in CMM activities will then be presented in the context of how they might help academic organizations in their ABET activities and how ASU applied each lesson.

BACKGROUND

The Capability Maturity Model (CMM) for Software [5] developed by the Software Engineering Institute has become the widely accepted standard for assessing the maturity of software development organizations and providing them with the guidance they need to improve. The CMM consists of key practice areas that successful software development organizations should adopt. The expectation is that organizations that follow the CMM will develop high quality products in a cost effective manner. Organizations at the highest level of maturity will also have metrics in place for assessing how well their processes work and procedures in place for continuous process improvement.

Demonstrating CMM maturity is a formal process in which organizations subject themselves to an assessment process. The results of this assessment can have significant financial implications in terms of future business, especially for government contractors. As a result, there is often tremendous pressure to achieve a successful assessment.

ABET has been empowered by the United States Department of Education to accredit engineering programs. Accreditation guidelines specify defined standards and criteria that a program must satisfy [1]. Accreditation provides evidence that a program has the capability of producing high quality graduates in an analogous manner that CMM assessment provides evidence that an organization has the capability of producing high quality software.

ABET’s Engineering Criteria 2000 is based on total quality management principles. Programs must define educational objectives and outcomes for graduates and demonstrate that these objectives and outcomes are met. This level of measurement and continuous process improvement is analogous to CMM level 4 and 5 activities.

In a software development organization, a CMM assessment is a high visibility activity with a lot a stake. The same is true for an academic organization undergoing an accreditation activity. In the software development community once an organization makes the decision that they desire to achieve a high CMM rating, there is much to be done at every level in the organization. In an analogous manner, a department seeking EC 2000 accreditation has a sizeable set of tasks to complete. Organizations have been striving to improve their CMM ratings for over a decade with a mixed level of success. There are many lessons that have been learned about performing this task successfully. Many of these lessons are applicable for academic departments seeking to receive EC 2000 accreditation. At Arizona State University several faculty members have been involved with CMM activities for many years. Their knowledge of the CMM process and the lessons learned by organizations undergoing CMM activities provided a basis for the ASU accreditation process. The next section identifies some lessons learned from industry that were applied at ASU.

LESSONS LEARNED FROM INDUSTRY

There have been many publications addressing lessons learned from trying to follow CMM processes [2-8]. Most of these publications contain a common theme. In this section, we will
summarize the lessons learned from industry and how these lessons were applied at ASU.

Lesson 1: A commitment must be made to improving via the CMM processes at all levels of management. Often this commitment is made by top management in an effort to improve the image of the organization or to satisfy customer requests. Unfortunately, this commitment may not be shared by lower level managers who must also manage specific projects with time and money constraints. This makes it difficult for them to prioritize activities. To be successful, all levels of management must recognize the value of CMM. This lesson has relevance for EC 2000. Often accreditation is something viewed as important by the Dean or even the President of the University. The Department Head must also share in this vision of the importance of accreditation. Unfortunately, the Department Head is most likely also concerned with research expectations and must balance these priorities. If the Department Head is not committed to this process, it is doomed to failure. At ASU this problem was addressed very early by ensuring that the President, the Dean and the Department Head all viewed accreditation as a high priority.

Lesson 2: Project personnel must be heavily engaged in CMM process improvement activities. They must understand the importance of these activities and they must commit to them. They must be involved in defining the processes and procedures to be followed. If they are not engaged in defining these processes, they will probably not be cooperative in following them. This lesson has relevance for EC 2000. If processes and procedures are not defined by the faculty, there will be no buy-in. Faculty must see the benefits of this process if they are going to commit to it. At ASU this lesson was applied via considerable faculty input on ABET processes.

Lesson 3: Funding must be provided for CMM activities. CMM requires considerable effort to define processes and to train people on how to effectively utilize these processes. This lesson has relevance for EC 2000. If faculty are to engage in defining EC 2000 processes, they must be compensated for their efforts via additional support or release from other activities. Adequate time must also be provided for training and education in effective utilization of these processes. At ASU in response to this lesson, an entire faculty retreat was devoted to developing our ABET process. Considerable staff support was also provided to assist faculty members in collecting and organizing ABET materials. Release time was also provided to key faculty members driving the ABET process.

Lesson 4: Corporate processes must be integrated with software development processes. It is difficult for a software development organization to improve its processes if they must conform to archaic and difficult to change corporate processes. This lesson has relevance for EC 2000. If a program is to be successful in continuous improvement, there must be flexibility in college and university requirements. There must also be an infrastructure which supports curriculum improvement and assessment information that can be utilized at the program level.

Lesson 5: Software development organizations need well defined standards and tools to support new CMM activities. This lesson has relevance for EC 2000. In particular, standards for defining objectives and outcomes as well as tools for supporting assessment information is needed to simplify EC 2000 activities. At ASU this lesson was applied early via definition of assessment instruments that were standardized and required minimal faculty inputs.

Lesson 6: The organization must tie CMM process activities with business goals. Typical business goals include achieving market share and making a good profit. Companies unsuccessful with CMM have not been able to demonstrate how achieving higher levels of CMM will help the organization achieve its business goals. This lesson has relevance for EC 2000. Each program should have defined goals. Often these goals are tied to research expenditures or national rankings. It is important that EC 2000 be tied to the department’s goals and the faculty understand how EC 2000 will impact these goals. Early in the development of the accreditation process at ASU this lesson was easy to achieve since one of our “business” goals was ensuring that our students were recruited by the top organizations who normally restricted their recruiting to only accredited programs. ASU business goals continue to evolve with a strong research funding, it is becoming more of align accreditation goals with our business goals.

Lesson 7: One of the difficulties in developing effective CMM processes is the lack of examples. Effective organizations study what others have done and model their processes after successful organizations. This lesson has relevance for EC 2000. Programs implementing EC 2000 should look to other institutions for examples of objectives and outcomes as well as effective assessment techniques.

Lesson 8: Successful CMM organizations develop simple processes and metrics. Simple processes and metrics have a higher probability of being followed. This lesson has relevance for EC 2000. Curriculum improvement processes must be simple and efficient. Metrics must be easy to collect and validate. This has been a driving consideration in the ASU accreditation processes.

Lesson 9: It is essential for a software development organization undergoing CMM process improvement to perform risk management for this activity. Risk management involves identifying what can go wrong, prioritizing these risks and developing mitigation strategies for either reducing the probability of the risk occurring or minimizing its impact should it occur. Examples of risks that might occur during
CMM activities include: loss of management support and nonconformance to processes. This lesson has relevance for EC 2000. Programs planning to undergo EC 2000 are subjecting themselves to risks such as lack of institutional support, lack of faculty support and inability to acquire valid assessment data. EC 2000 risks must be identified and continuously updated. Risk mitigation strategies must be developed and followed.

Lesson 10: Organizations successful in CMM implementation are diligent at monitoring their progress in developing processes and auditing their utilization. This lesson has relevance for EC 2000. A detailed plan must be developed for the ultimate goal of accreditation. Each step along this plan must be tracked. It is also essential to audit compliance with EC 2000 processes. This entails ensuring that faculty members are following the program’s EC 2000 process and effectively utilizing assessment instruments. This lesson was applied early and often at ASU. A detailed plan for accreditation was developed and tracked. An audit process was also developed to ensure that faculty members were complying with our new processes.

LESSONS LEARNED AT ASU

The Department of Computer Science and Engineering at Arizona State University recently successfully completed EC 2000 accreditation for both its Computer Science and Computer Systems Engineering degrees. Work on this accreditation has been taking place over the last 6 years. The lessons learned from industry were very applicable to our program and were applied. We were fortunate in having strong support for our accreditation activities for the past 6 years from all levels of the university administration. A strong EC 2000 committee was at work at the college level supporting and integrating department and college activities. “Funding” was also provided for this activity via summer support for key faculty members as well as release time for EC 2000 activities. Standard processes, forms and metrics were also developed to simplify the EC 2000 data collection activities. Auditing was performed as a part of our annual faculty evaluations to ensure that EC 2000 processes were being followed.

There were, however, problems that had to be overcome. Since most processes and procedures were developed by small groups of faculty, there was not always the buy-in needed. There was also sometimes confusion regarding the objectives, outcomes and assessment instruments which could have been overcome via additional training. Overall most faculty have come to appreciate the value of EC 2000 as a tool for improving the curriculum. The department has progressed from simply adding new topics and courses to the curriculum to identifying how objectives and outcome need to evolve and then mapping those to specific course changes. Conflicts regarding the contents of courses have even been resolved by going back to the abet process in terms of definition of overall objectives and outcomes and how each course contributes to them.

REFERENCES