Practical Approach to Development of SPI Activities in a Large Organization ~Toshiba’s SPI History since 2000~

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ABSTRACT
For the effective promotion of software process improvement (SPI) activities in a large-scale organization, it is necessary to establish an organizational structure and a deployment method for promotion and to develop training courses, support tools, and other materials. Even if an organizational promotion system is established, the SPI activities of each development department cannot be promoted effectively without SPI community. To promote SPI activities throughout the TOSHIBA group, we organized a Corporate Software Engineering Process Group in April 2000. We also have been focused to establish SPI community, while promoting SPI activities in each development department. The fundamental our operating policy of SPI is “bottom-up”. This paper discusses the problems encountered in the promotion of SPI activities and presents solutions to the problems. The actual results obtained show that the framework and solutions developed by us can be used to effectively promote SPI activities.

Categories and Subject Descriptors
K.6.3 [Software Management]:

General Terms: Software Process Improvement, CMM(Capability Maturity Model), IDEAL(Initiating, Diagnosing, Establishing, Acting, Learning)

Keywords: SPI framework, SEPG leader training course

1. INTRODUCTION
In recent years, software is used increasingly in various domains. Consequently, the scale and complexity of software is increasing, and development organizations are becoming large.

In order to build in higher quality and to develop large-scale or complex software efficiently, it is necessary to implement the optimum software development process in a development organization. Indeed, the development process of software has become a focus of attention in recent years.

We have used CMM (Capability Maturity Model) as a road map for SPI. However, in order to improve a software development process efficiently, it is not necessarily sufficient just to introduce such an existing process improvement technique.

Regarding the improvement of a software development process, the promotion system is an important factor in determining success or failure. In fact, process improvement changes the culture of a software development organization. Development organizations vary greatly in terms of culture, and it is seldom effective to apply a uniform process improvement technique as it is. So, it is necessary to tailor the existing process improvement technique for various organizations. For this reason, construction of the organizational promotion system is an important task.

This paper introduces the organizational promotion system for software process improvement activities implemented in the TOSHIBA group.

2. PROBLEMS RELATED TO THE PROMOTION OF SPI ACTIVITIES
Within the TOSHIBA group, process improvement based on the ISO 9001 quality system has been promoted. TOSHIBA group's experience of the promotion of process improvement indicates that the following issues may create problems in the setting up of an effective organizational promotion system.

1. Structure of the promotion organization: Considering the impact on the culture of the organization, an ad hoc promotion system for process improvement never functions effectively. A hierarchical management system is effective for the management of a large organization. In addition, it is necessary to build an organizational promotion system for each level of the hierarchy.

2. Infrastructure for process improvement promotion: Even if an organizational promotion system is established, the SPI activities of each department cannot be promoted effectively without the appropriate infrastructure. This infrastructure can supply common
information for SPI through a database. It is also useful to achieve a common recognition of the importance of SPI and, on that basis, guide SPI activities effectively.

3. Establishment of SPI community: SPI community is very important to extend SPI movement. In 1990s in Japan, many organizations started to get ISO certification for competition in the international marketplace. Many organizations that did not have strong technical identity rushed into certification racing. As a result, SPI activities in field projects were slowed down. If community is exist, such a situation must have been avoided.

4. Improvement of SPI capabilities: To promote process improvement systematically, it is important to achieve a common, accurate recognition of the importance and contents of process improvement. Only after this common understanding is achieved can software process improvement be implemented efficiently. In addition, if the skills of the people involved in SPI are improved, SPI activities can be promoted more effectively. Therefore, it is useful to provide training courses for the people involved in SPI.

### 3. SPI FRAMEWORK IN TOSHIBA

The purpose of software process improvement activities is to achieve the targeted QCD (quality, cost, delivery) in software development and to establish an organizational culture conducive to continuous improvement. Our final goal is to establish the KAIZEN culture in the TOSHIBA group. For this purpose, the Corporate-SEPG (Software Engineering Process Group), consisting of 6 persons, was established in April 2000. The number of Corporate-SEPG is 20 persons in 2005. In this section, we explain the SPI framework and three-level hierarchical structures of SEPG, describe the policy for promoting SPI activities in the TOSHIBA group, and introduce solutions to the problems identified in the preceding section.

#### 3.1 Long-term plan for SPI in TOSHIBA

In order to deploy SPI activities throughout the TOSHIBA group, it was necessary for Corporate-SEPG to earn the trust and cooperation of the members who promote SPI activities in each development department. For this purpose, we explained long-term SPI plan (Fig. 1) to the whole of the TOSHIBA group.

<table>
<thead>
<tr>
<th>Phase</th>
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<tr>
<td>1st Phase</td>
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<td>3rd Phase</td>
<td>2008-2010</td>
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**Figure 1. Long-term SPI plan in TOSHIBA**

The first phase of the long-term SPI plan was completed in March 2004, and the second phase was launched in April 2004. The first phase activities were, on the whole, carried out as planned. The results of our activities are explained in section 4 in detail.

#### 3.2 Framework for the promotion of SPI activities

We have used CMM as a road map for SPI. The process assessment method is used for understanding the gap between CMM and the process used in the organization. The improvement plan is developed and executed based on the detected gap. This improvement cycle is crucially important for the effective implementation of SPI activities. For the improvement cycle, we modified the IDEAL model. IDEAL consists of 5 phases, namely Initiating, Diagnosing, Establishing, Acting, and Learning.

To promote SPI activities in the TOSHIBA group, we proposed the framework shown in Fig. 2. The framework has the following features.

1. SPI activities are promoted by SEPG, which has a three-level hierarchical structure.
2. Techniques, such as CMM and IDEAL, and methodologies are not adopted as they are. They are tailored for practical use by each hierarchical level of SEPG and incorporated in the process improvement promotion organization.
3. Corporate-SEPG and Company-SEPG provide consulting services using their knowledge and various materials (CMM guidebook, improvement solutions, assessment techniques, etc.).
4. The TOSHIBA SEPG Conference and the TOSHIBA SEPG Workshop are important events for expanding the SPI community. The Conference consists of a keynote speech, presentations, and various special events (SIG, panel discussions, etc.), while the Workshop is aimed at enabling the discussion of selected topics in detail.
5. To improve the capabilities of SEPG members, corporate-SEPG provides training courses. The SEPG leader training course is essential for improving SEPG leaders' skills and making SPI network.
6. All materials (training texts, event materials, samples of process standards, CMM guidebook, etc.) are available at the corporate website.
7. Based on the SPI activities data, an SPI activities report is published periodically. This report details the progress of SPI activities in the TOSHIBA group, the current maturity level, current SEPG activities, and the effects on SPI activities.

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**Figure 2. Framework for the promotion of SPI activities**
3.3 Three-level hierarchical structure of SEPG
SEPG is divided into three classes as shown in Fig. 2 for promoting the SPI activities. We have identified the process improvement activities which change the culture of an organization. In order to promote these changes, an adequate grasp of the present culture and flexible action are required. The software products developed by TOSHIBA group are numerous and diverse, ranging from large-scale software such as power plant control software to embedded software such as cellular phone. Moreover, within Toshiba group, culture varies among the many business units developing these products.

How to systematize an organization for promoting process improvement throughout a large organization such as TOSHIBA group is an important issue. Our solution was to organize three classes of SEPG. The three classes of SEPG are Corporate-SEPG, Company-SEPG, and Business Unit (BU) -SEPG.

3.4 SEPG leader training course
SEPG leaders play an important role in determining how effectively and efficiently SPI activities are performed. Corporate-SEPG developed an SEPG leader training course for the SEPG leaders. This training course is spread over about 2 - 4 days per month over a period of four months.

The time schedule of this course is shown in Fig. 3. The purpose of this course, which involves lectures and homework, is to provide the trainees with a detailed understanding of each phase of IDEAL, a basic understanding of CMM, and a knowledge of techniques for promoting SPI. The course provides an opportunity for members of various departments to get to know each other and thereafter to share information related to SPI with each other.

These actions are important. In practice, however, it is difficult to carry out these activities in the development departments for following reasons:

1. Most development departments often do not have enough time to promote process improvement. The development cycle is becoming shorter.
2. New methods and techniques are sometimes difficult to acquire.
3. Know-how is not accumulated and fed back effectively. Important knowledge is often accumulated through experience.

To cope with these problems, we provide improvement solutions from software engineering point of view. Through service activities, a great deal of know-how can be accumulated. And, the accumulated know-how can be used. In order to effectively promote improvement solutions, it is important to have good relations between three hierarchical SEPGs. The aim of our improvement solutions is improvement of software quality. We provide 3 services:

1. Program quality analysis using program static analysis tools
2. Promotion of ASQ tools (static analysis tool, configuration management tool, bug management tool, reliability estimation tool, test case generation tool, etc.)
3. Establishment and execution of a training course on software engineering

3.6 Policy for SPI promotion in TOSHIBA
The fundamental operating policy of SPI is “bottom-up”. The major activity in early stage (2000 - 2001) was to support implementation of SW-CMM and training activities. After that work was finished, a number of BU-SEPGs have increased rapidly by sharing practical examples without legal force from “top-down”.

To change the culture of a software development organization, “bottom-up” approach is very important than “top-down” approach. We constructed and established communities various for SPI promotion. In case of “bottom-up” approach, these communities are key factor to accelerate SPI activities.

3.7 Importance of SPI community
TOSHIBA group members have been very eager to construct a knowledge-sharing community beyond the organizational barrier. They all know that it is necessary to rely on community power for solving various problems in SPI.

Usually, most of requirements and functions (user interfaces) of software system to be developed are given by customer. Software developers can only show their creativity in the process of implementing these requirements and functions as a real system.

Recently, many organizations are sensitive about information disclosure. Of course, we must be careful about information given from customers. But mutual exchange of process-related in-house information through mechanism is important and very useful for the SPI community.

In TOSHIBA, member organizations are sharing common issues in software process and jointly trying to solve problems. Rapid
growth of the number of SEPGs (Fig. 4) indicates that this open-process concept is accepted in TOSHIBA software community.

21 century is the age of software. We should continue SPI activities to encourage software developers. For that purpose, it is needed to promote information exchange beyond various organizational barriers. SPI promotion of TOSHIBA groups is a test case to implement such a mechanism.

4. ACTUAL RESULTS OF SPI ACTIVITIES

We applied SPI activities consisting of consultancy services based on CMM and the IDEAL model, training courses, improvement solutions, various events, and information sharing from April 2000 to March 2005. Due to the positive results obtained, it has been judged that our SPI activities should be extended to the entire TOSHIBA group in 2002. From April 2005, we moved to the second phase of our long-term plan. In this section, we present the effects of the hierarchical SEPG structure, the maturity profile of each development departments, and the effects of improvement solutions.

4.1 Effectiveness of the hierarchical SEPG structure

Fig. 4 shows the number of BU-SEPGs and Company-SEPGs. Since the establishment of the framework shown in Fig. 2, the number of BU-SEPGs has increased rapidly. This indicates that the organizational infrastructure required for systematic process improvement has been built and that SPI activities have been promoted. The key factor responsible for the success is the establishment of the hierarchical SEPG structure. It is particularly effective for Company-SEPGs to support BU-SEPGs in cooperation with the Corporate-SEPG.

There were 17 BU-SEPGs in 2001. Corporate-SEPG supported 16 of the 17 BU-SEPGs at that time. That is, the direct support ratio was 94%. However, the direct support ratio fell to 66% by 2005 because:

1. The main companies involved in software development organized Company-SEPGs, which took over support of BU-SEPG activities.
2. The capabilities of SEPG leaders were improved by the SEPG leader training course.

4.2 Maturity profile

We confirmed the effectiveness of the framework. As a result of our SPI activities, the number of SEPGs is increasing rapidly. Some organizations have reached SW-CMM level 2 and level 3 faster than the average reported by CMU/SEI. These results demonstrate that our proposed framework can accelerate SPI activities.

Fig. 5 is the maturity profile of SW-CMM level 2 in SPI activity report 2004. This graph was made using the SPI activities data from BU-SEPGs. It was found that almost all software development departments satisfied the maturity level of SW-CMM level 2.

Fig. 6 shows the maturity profile of SW-CMM level 3. About 60 percent organization has reached the situation of established and deployment. This shows that many people in TOSHIBA group can communicate each other by common language about software development process.

4.3 Change of a training style

Conventionally, training such as development process or software engineering was performed in class room style. Training is very important to promote SPI activities. However, training of class room style is not necessarily effective and efficient.

In the TOSHIBA SEPG Conference and the TOSHIBA SEPG Workshop, training is popular topic. In some presentations, there was a proposal that it was better to change a training style into workshop from classroom for effective training implementation. Many participants were received the stimulus from these
presentations. After these events, some practical results were reported to Corporate-SEPG.

5. SPI IN EMBEDDED SOFTWARE DEVELOPMENT

One of the uniqueness of Japanese IT industry is the strength in the embedded system product manufacturing. In the past, importance of software components in these products was rather small comparing with hardware parts. Embedded software components were developed in rather ad hoc style.

But the size and function of embedded products has been increased rapidly. For example, in the case of high-function cellular phone, the size of embedded software is several million steps. Nowadays, software development project teams consist of several hundreds engineers, and have a number of management layers. Current issues in embedded software development are:

1. How to coordinate hardware development unit with software development unit
2. How to deal with rapid growth of software size and shortening of project cycle
3. How to manage large scale development project

From now on, embedded software will become more and more important along with the penetration of a variety of products into the various aspects of society like automobiles, home electric appliances, mobile terminals, etc. Japan has been leading international market in some of these fields. In the future, it will be a unique role of Japan to make contribution to the world by combining its high quality hardware manufacturing process with new style of software quality/project management method.

6. CONCLUSION

We have described short history of SPI activity in TOSHIBA, and made an analytical consideration about the status of SPI in TOSHIBA. Unique character of software process improvement in TOSHIBA is that it is a collection of bottom-up cooperation among software engineers beyond the organizational barriers in which they are working. Our SPI activities are considered as a mechanism to promote this kind of mutual knowledge exchange. We hope to enlarge this movement into international domain in future.

7. REFERENCES


