Improving Product Quality through Audit System Established for Development Processes

● Souichi Nagata ● Satsuki Shimada

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Fujitsu has implemented a product development project audit system involving a series of third-party evaluations of each product development process in order to incorporate quality in the upstream processes of product development and prevent failure from affecting downstream processes. Under this system, the quality assurance unit and selected members of the development division team audit the state of development based on the experience of development personnel and criteria based on the CMMI model. An audit is conducted in three phases of development: planning, implementation, and pre-production testing. As the audit progresses, the team determines a schedule and necessary action to promptly and reliably correct any problems extracted from the audit. In this way, the quality of our products is assured through compliance with product development processes, along with comprehensive and continuous improvements made to these processes.

1. Introduction

Based on an analysis of information on past failures involving Fujitsu products, we consider it necessary to incorporate quality in each development process. Promoting the "top quality expected by customers" necessitates compliance with and continuous improvements to the product development processes. For that purpose, in 2004 Fujitsu officially implemented a timely development review audit system and quality level evaluation system run by a third party (a quality assurance unit independent of the product development division). We have now introduced these systems as the product development project audit system for all products developed by Fujitsu.

This paper outlines the product development project audit system, describes the process improvement activities, and summarizes the results.

2. Product development project audit system

In the product development project audit system, the third-party department checks whether a given product development process established for each product complies with the specified product development process and whether products produced in that development process comply with industry-leading levels of field quality in accordance with a series of process check criteria including international process criteria (e.g., ISO9001,[1] CMMI[2),3)]) and Fujitsu's own extensive know-how.

This audit system is run in the product development process (**Figure 1**).

ISO and CMMI target continuous activities for improving the processes of a development organization. In contrast, the product development project audit system is designed to detect signs of quality problems in a product development project and make corrections to

downstream development processes.

The product development project audit is conducted according to three actualities: the actual location of a trouble, actual objects at that location, and actual happenings at that location. We visit the site where a project is being undertaken to confirm the products being developed and related development records, and understand the status of the project.

Indications pointed out in the product development project audit are classified into four risk levels (S, A, B, and C) according to importance. These levels are defined as "quality risk values". The total of these quality risk values denotes the "project risk". We use project risk in an audit to determine whether to continue or discontinue development. If the risk exceeds the criterion, the third-party department recommends that development be suspended or closely monitors the project as one requiring caution. Project risk is also used in benchmarks between audited products and analyses conducted on an organization basis.

2.1 Product development project audit team

A product development project audit team consists of a leader, two clerical workers, and an auditor from each development division. The team can confirm technical problems inherent in a product because the auditor from an audited department who understand the environment and conditions of the development division participates in the audit.

Management personnel selected from the quality assurance unit and each development division are registered as auditors based on the qualification criterion.

2.2 Targets of product development project audit

The audit targets all products developed by Fujitsu. The development processes of hardware, firmware, and software for each product and compliance thereof are audited.

2.3 Period to conduct product development project audit

An audit is conducted from the start of a product development project to its completion. As shown in Figure 1, this audit is conducted in three phases of development: planning (upon establishing a development project), implementation (during the development process), and prior

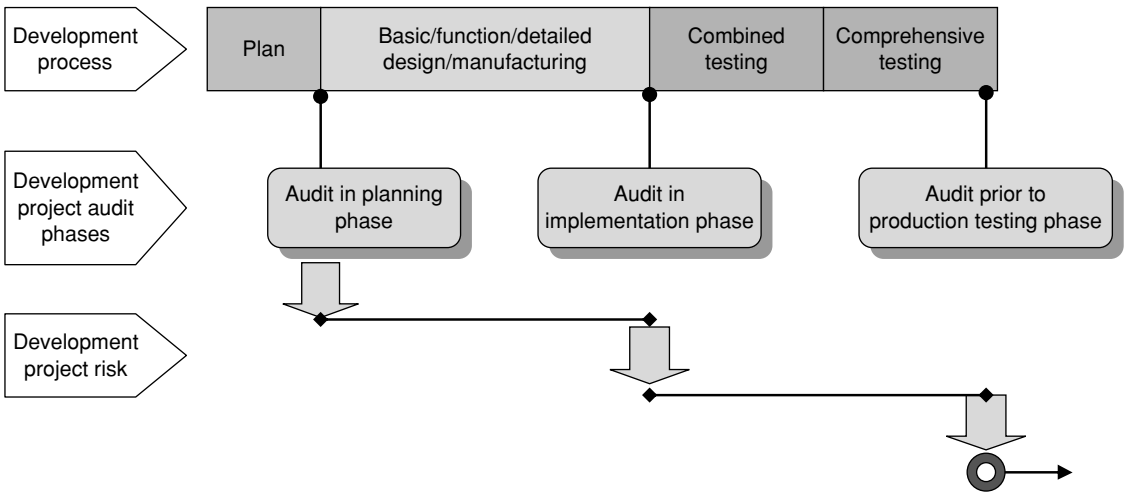


Figure 1
Summary of product development process audit system.

to production testing (after the development division completes verification). The audit team visits the field and conducts interviews with development division personnel.

1) Audit in the planning phase

This audit is conducted upon the establishment of a product development plan. In this phase, the established development plan and project input information (e.g., requirements, basic specifications) are audited. Major audit details include development items, the schedule, scale of development, cost (e.g., person-hours, facilities), quality planning (performance, quality indicators, and target values), whether project risk has been considered based on explicit grounds, and whether the estimation and plan are appropriate when viewed objectively. The team investigates feedback from the previous product, handovers, information shared between organizations, and related products. The team also confirms whether such information is well known to the development staff.

The divisions involved in a development project hold meetings to discuss the development plan. The audit team confirms the status of problem management at the meetings in the audit conducted during the planning phase.

In all audits, the team checks the existence of any development documents, as well as the contents of the plan, the approach to the plan, and proofs. The team points out any problems in the project planning when the project is launched and has the staff resolve such problems as soon as possible.

2) Audit in the implementation phase

The audit in the implementation phase is conducted once the design phase of development has been completed and an intermediate outcome determined. The team checks whether the project is being undertaken relative to all items in the established development plan.

In the audit conducted during the implementation phase, the team reviews raw data maintained by the development side including scheduling conditions, records of person-hours and outcome, quality conditions in each development process, correspondence to changes and additions of specifications, and the management of newly emerging risks, and then extracts any deviation from the development plan.

The audit team confirms the reasons for and countermeasures against any deviation, the management conditions, and then reexamines the plan.

In particular, the quality conditions to be confirmed include the degree of attainment against the target quality value in each process established during the planning phase, an analysis of quality, and judgment of whether the process has been properly completed before proceeding to the next process. The team confirms their evaluation and judgment through quantitative analysis using quality data such as the number of bugs detected and through qualitative analysis of individual content and overall tendencies in a comprehensive manner. The team thus checks quality in a highly sophisticated manner.

3) Audit in the phase prior to production testing

An audit in the phase prior to production testing is conducted following a comprehensive verification of the products developed (e.g., comprehensive testing). After this phase, a quality assurance unit other than the development divisions conducts a qualification test as part of production testing.

This audit is intended to guarantee the quality of final products and development processes in the development division based on the records of products evaluated by the development division, risk management conditions after the audit in the implementation phase, and management conditions relative to challenges and problems.

For the evaluation records of products, the team checks the status of problems that occurred in the test, the details of valuation analysis

regarding performance and quality targets, and whether final products have the required quality.

2.4 Improvement of audit system

The information from each product development project audit is accumulated in the audit system to unify management so that we can share the information in a timely manner. We also monitor the conditions under which trouble occurred in the evaluation division and the status of field problems as needed. We analyze the information, review the audit items, and improve the audit method (e.g., organization of an audit team and audit procedure) in order to execute PDCA (Plan, Do, Check, Act) in the audit system.

3. Process improvement activities

We post proposals on a Website of our intranets that can be used effectively to improve the development processes of development divisions for the Fujitsu Group by analyzing information about each development division collected in the product development project audits and through claims.

Many people have visited the Website and we have received many inquiries. Therefore, the use of this system positively impacts and improves the product development processes in product development divisions, as well as the management of projects based on this system.

The following describes some of the proposals posted on the Website and provided to development divisions.

3.1 Database for improving development processes through audits

The database for improving development processes through the audits consists of 13 viewpoints, including project planning, progress management, analysis of requirements, verification (reviews/testing), management of outsourcing, risk management concerning information about drawbacks and advantages of a development obtained from a development project audit, and corrective strategies. These 13 viewpoints are obtained from an analysis of the trends in claims based on the process area at levels 2 and 3 of CMMI V1.1. As of February 2007, more than 700 cases have been registered. The contents are also updated on a regular basis.

The advantages and innovations of the development processes of a development division, the tools used, levels (S, A, B, and C) of defects pointed out in audits, descriptions of defects, and corrective action are edited and published based on the 13 viewpoints.

This database effectively improves processes, confirms the state of individual projects in terms of the start period of a project and the period of audits, and pinpoints any problems.

3.2 Self-check sheet

The self-check sheet contains the viewpoints to be clarified when planning a project and the defects pointed out in past audits corresponding to the viewpoints.

These are the contents derived from a number of claims and content analysis concerning a product development plan in the classifications of defects pointed out in the audits.

A guidebook has also been published for promoting use of this self-check sheet by development divisions. This guidebook contains defects pointed out in audits of development projects in descending order of frequency. Each check item consists of four items: a keyword, self-check questions, actual defects pointed out in audits, and explanations of planning items. Above all, the explanations of planning items include items to be planned and their meanings, and function as a guide for acquiring know-how in planning a project.

Quality indexes for products and processes are most frequently pointed out, followed by the judgment and criteria of completing each development process.

3.3 Product development project audit tool

We have introduced the audit system for planning product development project audits, managing the status of implementation, making audit activities more efficient, and sharing information among auditors.

This system manages the latest information related to product development project audits, including whether each development project audit has been conducted, the contents and approval status of development project audit reports, and strategies to cope with defects pointed out in audits based on the development project audit plan.

The audit team uses this system in preparing audits and submitting audit reports. This system prevents audit activities from being omitted or delayed, and thus enables effective activities.

3.4 Development process education

We have prepared development process education materials (published for development divisions) in order to improve knowledge about quality.

Two types of materials have been published: 1) e-learning materials for self-learning and 2) development process guidelines that explain the ideal processes indispensable for undertaking development projects.

We have developed and run courses for both types of published development process education. These educational courses are customized as requested by individual development divisions. Staff members can acquire practical skills by incorporating practices that cannot be taught in classroom lectures.

For the development process guidelines, 17 types of materials are published, covering development planning, progress management, and risk management categorized into four areas: project management, engineering, support process, and process management.

This development process guideline describes ideal development processes in line with specific approaches so that staff members of the development divisions can easily understand the material. This guideline is effective for confirming the contents of e-learning more specifically and broadening knowledge about quality.

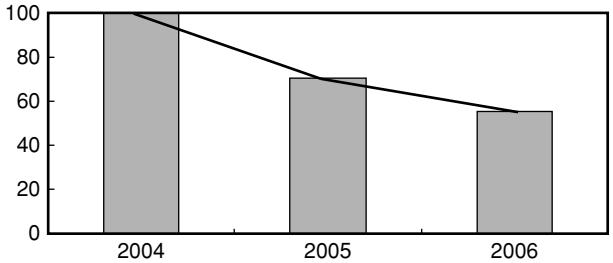
More than 3000 staff members have used the guideline since initial publication in 2005, given its editing in consideration of actual teaching needs.

4. Results of running product development project audit system

More than two years have passed since the product development project audit system was first introduced. The following summarizes the project risks that have been evaluated quantitatively in audits as the results.

The average project risk detected in each development audit has been reduced since 2004. Specifically, risks have been reduced by at least 40%. With regard to the quality risk value of each defect pointed out, the number of quality risks having higher values is decreasing. This shows that the overall level of development processes has been improved (**Figure 2**).

Audits conducted in a timely manner by third-party departments corresponding to the progress of developments and prompt responses may largely contribute to these positive results.



note) Assuming 100 as the quality risk value in 2004.

Figure 2
Annual change in average project risk value.

5. Conclusion

This paper described the characteristics of an audit system established for development processes, explained process improvement activities, and summarized the results of these activities. We will collect and analyze information inherent in each project through the audits, as well as quality information after shipment in order to realize strategic audits. We also intend to further improve quality through these activities in the future.

References

1) International Organization for Standardization: ISO 9001: 2000 Quality management systems — Requirements.
http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=21823
2) Software Engineering Institute | Carnegie Mellon: CMMI for Development, Version 1.2.
http://www.sei.cmu.edu/publications/documents/06.reports/06tr008.html
3) Software Engineering Institute | Carnegie Mellon: CMMI for Development, Version 1.2, CMU/SEI-2006-TR-008.
http://www.sei.cmu.edu/pub/documents/06.reports/pdf/06tr008.pdf

Souichi Nagata, *Fujitsu Quality Laboratory Ltd.*
Mr. Nagata received the B.S. degree in Electronics Engineering from Akita University, Akita, Japan in 1977. He joined Fujitsu Ltd., Kawasaki, Japan in 1977, where he has been engaged in software quality assurance activities for more than 20 years. He is a corporate vice president of Fujitsu Quality Laboratory Ltd.

Satsuki Shimada, *Fujitsu Quality Laboratory Ltd.*
Ms. Shimada received the B.S. degree in Business Engineering from Shibaura Institute of Technology, Tokyo, Japan in 1987. She joined Fujitsu Ltd., Kawasaki, Japan in 1987, where she has been engaged in research and development of switching system software for more than 10 years. She belongs to the Product Process Audit Division as the Product Development Process Audit Group Manager. She has been a board member of the Society of Project Management (SPM) since 2002. Also, she is the chairperson of the publishing committee of the SPM.