Efforts to Acquire Automotive SPICE Certification in Automotive Software Development

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Having been formulated as the industry's standard process model/assessment model, Automotive SPICE(1) *provides a common framework for in-vehicle device software development processes. With the promotion of Automotive SPICE-based process improvement as part of software quality improvement activities, Mitsubishi Heavy Industries Thermal Systems, Ltd. (MHI Thermal Systems) acquired Level 3 certification for the development capability of its electric compressors for automotive air conditioners. This report describes the various activities and strategies we undertook for the acquisition of the certification.*

1. Introduction

In developing automobiles, the importance of software development is increasing markedly, and assuring software quality is a primary concern to the automotive industry as a whole. As a solution, the Quality Management Center (QMC) of the German Association of the Automotive Industry (VDA or Verband der Automobilindustrie) adopted ISO/IEC 15504 (commonly known as SPICE or Software Process Improvement and Capability dEtermination)(2) as the basis for formulating Automotive SPICE a common process-model framework for automotive software development. Automotive SPICE has been widely used to improve development processes or assess development capability.

MHI Thermal Systems develops and manufactures automotive air conditioning systems. To assure the quality of software embedded in our products, we took on the challenge of improving our software development processes in accordance with Automotive SPICE, and with regard to the development of software for automotive electric compressors, acquired Level 3 development capability certification in compliance with Version 3.0 of Automotive SPICE, which is a requirement demanded by many automotive manufacturers. The following activities that we have initiated will be introduced:

- Setting up of the Software Engineering Process Group
- Streamlining of in-house standards, procedures and guidelines
- Building of information sharing systems
- Establishment of audit methodology and auditor training

2. Process improvement activities

2.1 Setting up of the Software Engineering Process Group

Because Automotive SPICE is a common framework, its definitions are expressed in highly abstract terms. It is therefore necessary to accurately understand and interpret what is written and then make it practically applicable to actual activities. As the first step, the Software Engineering Process Group (SEPG) was set up within the Design Department to lead the activities. Since the group members should have (1) full knowledge of the conventional software development work

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and (2) understanding of Automotive SPICE, designers with sufficient software development work experience were assigned to the task. Moreover, they participated in the official Automotive SPICE Assessor training course and became qualified as Provisional Assessors. At present, MHI Thermal Systems has four assessors (including the quality assurance auditors, which will be described later).

2.2 Formulation of in-house standards, procedures and guidelines

Of the total of 31 processes defined in Version 2.5 of Automotive SPICE, 19 were identified as necessary for our software development. The workflow of each process and the process definition document in which tasks to be performed are defined were formulated (**Figure 1**). Furthermore, the procedures that specify what should be done in each task and the guidelines were streamlined, and were made available as in-house standards. These standards are accompanied by 26 work product templates that are required to be used in the software development workflow, thereby minimizing inconsistencies in documented entries among task owners.

We also defined a system to tailor development processes according to the scale and features of a project, thereby making it possible to flexibly adapt the system to various development projects.

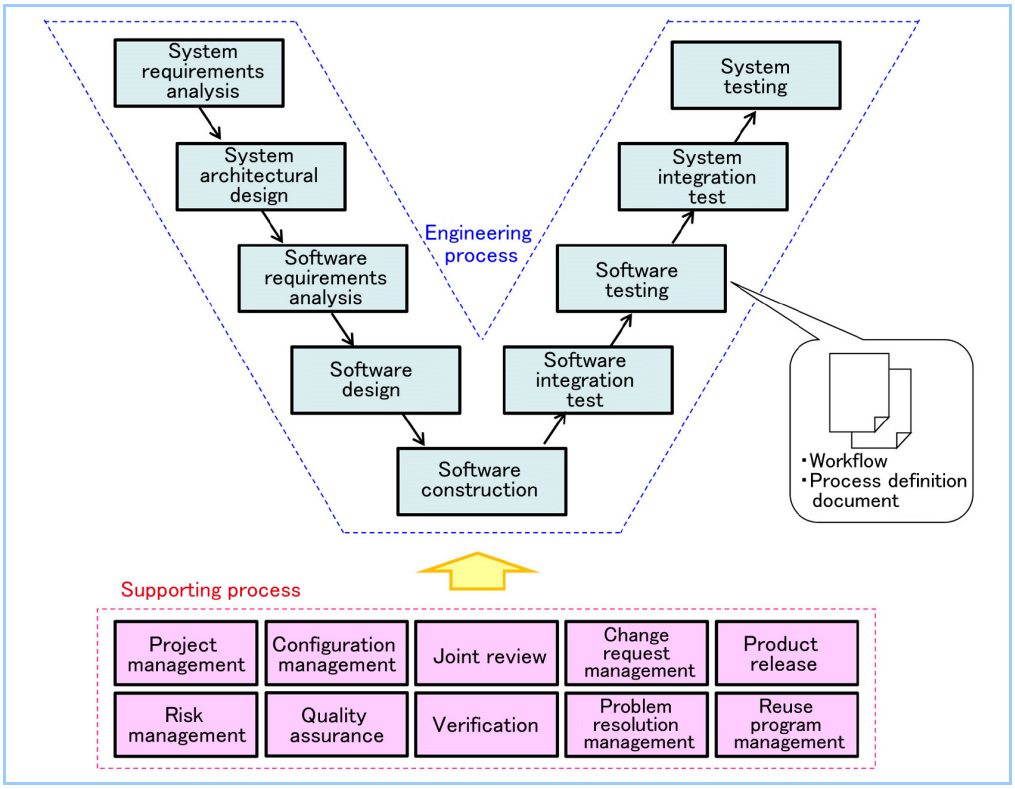

Figure 1 Software development processes

2.3 Building of information sharing systems

To realize consistent information sharing/management throughout the development life cycle, a variety of systems have been introduced depending on the type of information handled.

(1) Progress management

The development work is broken down to the level of task owners (Work Breakdown Structure or WBS). These tasks are registered in the system we introduced to manage schedules. With this system, we have created an environment in which managers and stakeholders can check the work progress of all project members at any time. As the system is used by all project members on a daily basis, a web browser-based application has been adopted so as not to be subject to license restrictions. In this system, input entries are customized depending on the type of work (i.e., design task, risk management task, change request task, or problem resolution management task) and the consolidated management of necessary and sufficient information has been enabled.

(2) Requirements management

A requirements management system has been introduced to clarify and maintain bidirectional traceability that shows links between client requirements, software requirements,

software design, code and test results. As traceability in software development needs to maintain one-to-many or many-to-many associations across multiple layers (**Figure 2**) rather than one-to-one associations, it is essential to use a dedicated system. When a change has to be made, the use of this traceability can narrow down and indicate which parts of the processes will be affected by that change, helping to prevent omissions.

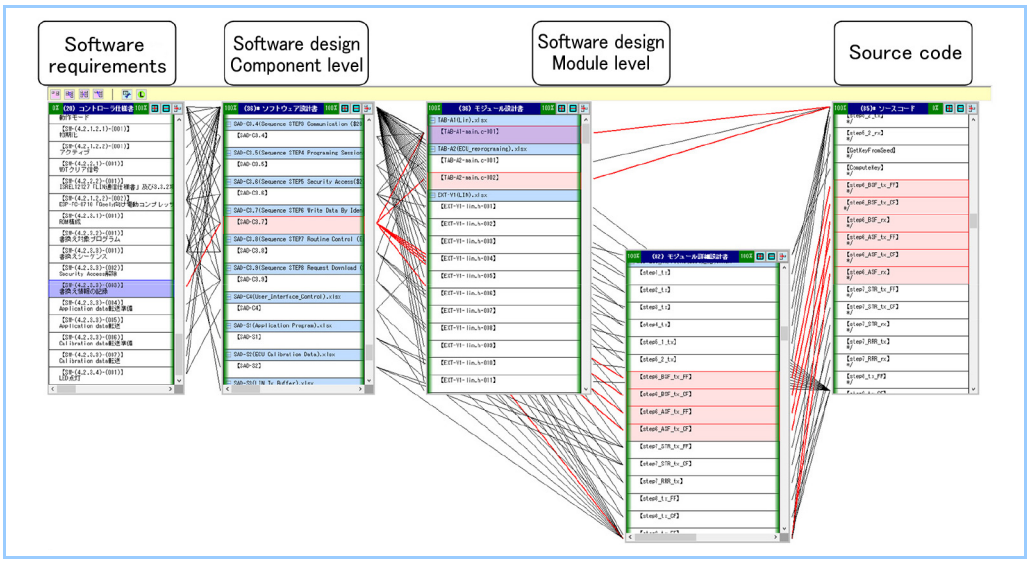

Figure 2 Software traceability example

(3) Configuration management

To assure the validity of work products such as requirements specifications, software design documents, source code and test reports (all of which will make up software components), a configuration management system has been introduced, by which the history of all changes and their derivative changes can be recorded and retained on an electronic file basis. As the same database is accessed in all projects, design assets can be shared across multiple projects. This system can also be used for cause analysis of problem, etc., because once a problem arises, it is possible to trace the history of changes and completely recreate a situation in the past.

In this system, file management is closely associated with the recording of reviews, which allows the system to function as evidence that all post-review corrections have been properly carried out.

2.4 Establishment of audit methodology and auditor training

Software problem occur mostly because of a lack of objectivity (that is, the preconceptions of task owners). To eliminate this, we have established a system of quality auditing performed by a third-party department. For each of the work products and development processes, an audit check sheet has been prepared. The audits are provided mainly by those officially qualified as Automotive SPICE Provisional Assessors.

3. Conclusion

With the promotion of software development process improvement based on Automotive SPICE, MHI Thermal Systems set up a group to promote improvement, prepared the organizational standards, procedures and guidelines, and introduced supporting management systems for software development. A methodology for quality assurance auditing by a third-party department was also established. In the development of electric compressors for automotive air conditioners, we acquired Capability Level 3 certification in compliance with Version 3.0 of Automotive SPICE. We will continue to improve and optimize these processes, targeting further improved quality of air conditioning and refrigeration system products.

References

(1) VDA/QMC Automotive SPICE Process Assessment Model v2.5
(2) ISO/IEC 15504