行政院國家科學委員會補助專題研究計畫成果報告

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※一支援 ISO-9000 之整合性網際計算環境的研究製作 ※
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計畫類別：V 個別型計畫　　□整合型計畫
計畫編號：NSC 89-2213-E-009-011
執行期間： 88 年 8 月 1 日至 89 年 7 月 31 日

計畫主持人： 王豐堅
共同主持人：

本成果報告包括以下應繳交之附件：

□赴國外出差或研習心得報告一份
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□出席國際學術會議心得報告及發表之論文各一份
□國際合作研究計畫國外研究報告書一份

執行單位：國立交通大學資訊工程系

中 華 民 國 90 年 2 月 26 日

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計畫參與人員：蔡慶鴻等四名研究生

一、中文摘要

ISO-9000 系列是用來增進公司或組織作業效率、增進生產力而訂立的國際化標準。目前，尚未有完整支援 ISO-9000 **之軟體；不過，許多電腦研究機構致力於應用流程支援系統 (Process-support System) 於軟體專案發展。一個完整的軟體流程環境 PSEE(Process-based Software Engineering Environment)輔以正規而且嚴謹的軟體流程定義(Software Process Definition)已經被證實有助於分析與評估軟體流程，因而增加效率，降低成本，提高軟體品質。**

為了使一組織可以有一套完整的電腦輔助環境來幫助定義符合 ISO-9000 標準之流程並且加以執行，藉以縮短獲得認證之時間，真正日常落實 ISO-9000 **之實施與降低其成本。我們在本計畫中以軟體流程 PSEE 為基礎，檢討必需的工具，構想一套 ISO-9000 認證輔助系統，稱之為 ISO-CARE**(ISO-9000 Certification Aided enviRonmEnt)**，並且在網路集中計算環境(Network Centric Computing)之下的** PSEE **製作出此一系統在軟體領域發展的一雛形。**

關鍵詞：ISO-9000 認證，軟體流程定義，品質系統，軟體流程環境，網路集中計算環境

1. Abstract

ISO-9000 series standards have been accepted as standards of international quality systems worldwide in industries. Currently, there is no software used to design, construct and maintain quality system complied with ISO-9000 completely. Existing softwares only automate some aspects of quality management, such as document management, process control, and gradation tracing. This article presents an ISO-9000 Certification Aided enviRonmEnt, ISOCARE, that is a Process-Centered Software Engineering Environment. ISOCARE integrates sets of aided tools to support Process Supporting ISO 9000 certification, which can help further organizations to follow ISO-9000 rules. A prototype applied for software development with ISOCARE has been developed.

Keywords: ISO-9000, software process technology, process-based software engineering environment, quality management system, network-centric computing.

2. ISO 9000 and Current Supporting Environments

2.1 ISO 9000 Series of Standards

The ISO 9000 standards are series of international quality standards; they can be applied to the QMS to help produce qualified products [1][2]. ISO 9001, 9002 and 9003 are three individuals but related standards, as shown in Figure 1, and a company can select a suitable standard based on its characteristics. The generic nature of the ISO 9000 series makes it difficult to apply the series to an application directly. To overcome the difficulty, a guidance document, ISO 9000-3, has been developed to provide detailed information on implementing ISO 9001 in a software environment [1][2].

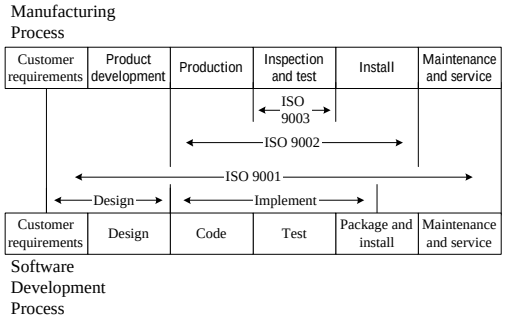

Figure 1. Relationship of ISO 9000 standards to the development process

A QMS that is complied with ISO standards requirement can be discussed from the following viewpoint [2]:

(1) Personnel part: different roles, including worker, quality manager, purchaser and subcontractors need to be aware of and make sure of their own responsibility.
(2) Product part: all product parts, including internally developed parts, product documentation, and subcontracted parts, must be controlled, identifiable, traceable, and verified.
(3) Project items: phases of project development, such as requirement, project plan, design output, test plan, service plan and quality record, must be controlled; and the QMS should demonstrate its effectiveness and

auditability correspondingly.

(4) Support items: the support items include quality policy and objectives, procedures, internal quality system audit, etc. These support items must be documented, effective, controlled and continually improved.

2.2 Comparison of Current Supporting Environments

With the acceptance of ISO 9000 standard series globally, more and more applications or environments which claim ISO 9000-supported appear on the software market [3][4][5][6]. Table 1 is a comparison of current ISO 9000-supported environments. Most of these ISO 9000-supported environments are developed over Lotus Notes; they take advantage of the groupware software, such as workflow applications with integrated electronic mail, built-in development tools, database management, etc. However, most environments focus on documentation required by ISO 9000. Existing environments only automate parts of ISO 9000 requirements via workflow in Lotus Notes. These cause that processes and procedures lie in documents only and can hardly be executed in real world. Too much paperwork and too many rules only make organizations more bureaucracy [7].

	Distribution technology	**Documentation system**	**Process/Procedure enactment**	**Tool integration**	**Steps to ISO 9000 conformance**
QMX4.5	Lotus Notes	User create	Lotus Notes Workflow	Lotus Notes groupware	On-line help manual
Q-Plus	Lotus Notes	Automatic generating from templates	N/A	Lotus Notes groupware	On-line help manual
Design Procedure	Client-Server	Automatic generating from templates	N/A	Flowchart drawing tools	On-line help manual
ISO Achiever plus	Lotus Notes	Automatic generating from templates	Lotus Notes Workflow	Lotus Notes groupware	On-line help manual
THExPERT	Lotus Notes	Automatic generating from templates	Lotus Notes Workflow	N/A	On-line help manual

Table 1. Comparisons of ISO 9000-supported environments

ISO 9000-3 characterizes the quality system as an integrated process throughout the entire software life cycle. Using an additional integrated system, such as the PSEE, to achieve process enactment can be a feasible way.

3. A PSEE for ISO

3.1 PSEE architecture

PSEE is an environment supporting software development activities. The high-level architecture of a PSEE is shown in Figure 2.

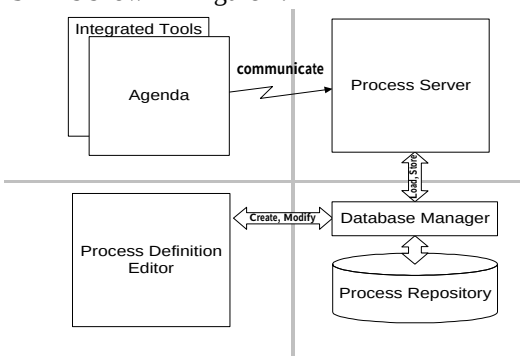

Figure 2. The high-level architecture of a PSEE

A process model may contain activities to be done, artifacts to be manipulated, roles to execute the activities and resources to be consumed. Process models and other information are stored in a process repository. A process model is enacted as a process in a process server. Participants can monitor the progresses of processes, acquire a task, and report the result through agendas. Integrated tools are designed to help accomplish tasks for users who involved in the PSEE. Besides, users can define a process model with process definition editor (PDE) in a process modeling language (PML).

3.2 Support ISO 9000 in a PSEE

There are several characteristics of ISO 9000 conforming quality system [2]. These requirements and our corresponding implementations in PSEE are:

(1) Quality objectives. In PSEE, quality policy can be treated as an artifact dispatched to all the roles and maintained by certain roles consisting of highest-levels of management. Moreover, the process designer has to model the strategies achieving the quality policy into processes clearly.

(2) Commitment, involvement, and attitude. All employees and managers must be committed and devoted to achieving the quality objectives. The documented procedures must be modeled into process models involved all people to achieve the objective addressed in

quality policy.

(3) Control. For items related to the product or development of the product, there need owners with authority to approve changes and procedures for requesting, reviewing, and approving changes. Authority can be modeled as certain roles responsible to some activities or artifacts in PSEE. And the procedures can be modeled into enactable processes.

(4) Effectiveness. It is needed to demonstrate and improve its effectiveness, and determine the cost of quality. Assistant tools are necessary to analyze the results of enactment of processes to show the effectiveness and the cost. The analysis can also be used to improve the processes.

(5) Auditing. During the development process, ISO 9000 requires the ability to show where the process proceeds, what has been done, and what has yet to be done. In PSEE, the progress can be monitored at a process server.

(6) Documented quality system. The quality system, including processes and procedures, should be documented. It needs tools to accomplish the tasks of documentation.

(7) Continual improvement. The quality system should be continually monitored and reviewed for weaknesses and that improvement be identified and implemented.

Our methodology [8], to build and execute QMS complied with ISO 9000, divides QMS life cycle into four steps: pre-processing, designing, execution, and modification, as shown in Figure 3.

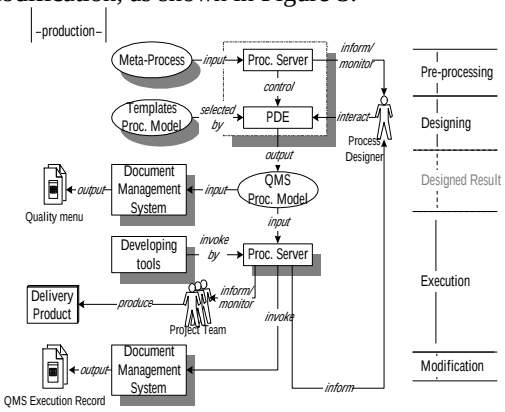

Figure 3. A process-based view of ISO 9000 in ISOCARE

A meta-process is designed to help process designers to follow steps to build ISO-complied QMS. In pre-processing step, it enacts a meta-process to guide the process designer to understand the ISO 9000. A meta-process also guides process designers to design process models as QMS complied with ISO 9000 via the PDE in designing step. After finishing QMS design, it enacts these process models designed in a process-enacting environment. With the execution of process models, the manager can audit QMS periodically, or to modify the QMS in real time. After executing the process models, it may need the performance and the result to do further process improvement required in ISO 9000.

4. Integrated Tools in ISOCARE

In addition, there need several integrated assistant tools: *Process analyzer* serves as a syntax checker of process models. *ISO standard compliance checker* examines the process models of QMS whether they comply with the ISO standards. *Documentation management system* handles all the documents required by ISO 9000, like automatic generation, version control, etc.

4.1 Documentation Management System

Documentation management system maintains the document required by ISO 9001. The document required by ISO 9000 can be structurized into a four-level model [9]. Quality manual, quality procedure documents and work instructions can be generated by extracting information from process models and filled extracted information into corresponding document templates. The relative extracted information is shown in Table 2. For quality manual, it demonstrates why the company sets up QMS. It can be written by the company manager, or be automatically generated from the synopsis statement defined in each activity in process models. Quality procedures document the quality plan and define the implementation strategy. They can be generated from information about role, activity, entrance condition, and department of agent defined in process models. Work instructions show the detail implementation steps and can be generated from state transition of process models. Quality records are the result of execute QMS and can be generated from collecting the logs of PASE process server.

As Figure 4 shows, documentation management system extracts entities from process models, constructs symbols and its relative values into symbol table, replaces symbols in document templates with relative values in symbol tables, and then generate documents automatically. Users can also fill the document templates by themselves. An example of symbol table is shown in Table 3. All the values of symbols are defined in process models.

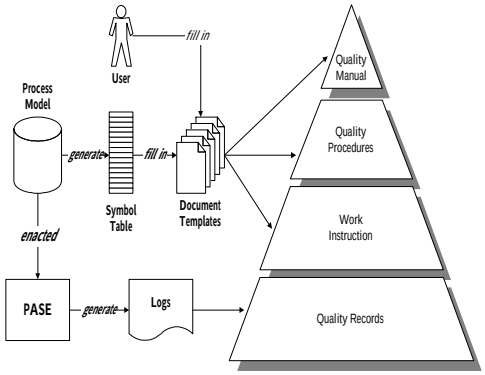

Figure 4. Document generation

Figure 5 shows an example of document templates. All words in anchors are symbols. Users can edit their generated document template with text editors in the same style [9][10].

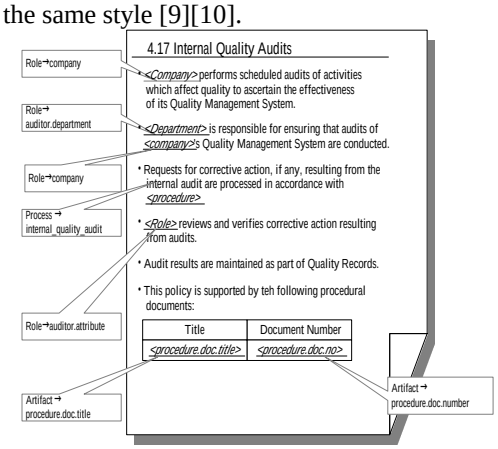

Figure 5. Example of document template

Document Pyramid		Document Management System Generation
Quality Manual	– Why	Synopsis in Process Model
Quality Procedure	– Who	Role in Process Model
	– What	Activity in Process Model
	– When	Entrance Condition in Process Model
	– Where	Department of agent in Process Model
Work Documents	– How	Process State Transition Diagram
Quality Records	– Evidence	Employee Write down, Logs of PASE

Table 2. Document Generation Rule

Symbols	Values	Defined in
<Company>	ABC Company	Role Tree->Company
<Department>	QM Division	Role Tree->Auditor.department
<procedure.doc.title>	Auditing Initial Plan	Artifact->procedure.doc.title
<……>	……	……

Table 3. Example of symbol table

Document management system also provides the function of version controls required in document control in ISO 9000, including:

(1) Re-issue documents after a practical number of changes have been made;
(2) Remove out-dated documents from circulation;
(3) Provide appropriate documents at all locations where quality systems are performed.

4.2 Process Analyzer

After modification of process models, process model inconsistency may occur. These inconsistencies include unfilled fields of an entity, entities not referenced, mismatched entrance conditions and exit conditions, etc. Process analyzer then handles these inconsistent conditions as a syntax checker of PLAN. To find out unfilled fields of an entity, process analyzer has to check every object in a process model whether there is any undefined attribute. Besides, the analyzer helps scheduling QMS in the graph. Many algorithms can be applied to the process models. Examples are Petri-Net, CPM/PERT algorithms, etc [11].

4.3 ISO Standard Compliance Checker

ISO 9000 compliance checker serves as a semantic checker rather than a syntax checker. The major design task is mapping the requirements of ISO 9000 into the checking items of semantemes in PLAN. For example, one requirement in ISO 9000 is:

"Internal quality audits shall be carried out by personnel independent of those having direct responsibility for the activity being audited."

The compliance checker has to find out the role tree of the process model defined in PLAN. In QMS, a role is in charge of the internal quality audits and the role of the activity is audited. Because a role tree shows the organization and hierarchy of a company, compliance checker can check the role tree to see whether two roles in the same department to determine independence of responsibility. Table 4 is part of check rules. Each check rule is a small function of ISO standard compliance checker.

Requirement of 4.17 Internal Quality Audit		Check Rule
The Audit Team	• Auditors aren't directly involved in the audit.	Entity: role of auditor doesn't in the audited dep.
	• Auditors have sufficient seniority in the company to reflect the importance of audit	Guide: guidance exists
	• Auditors are trained in auditing technique.	Relation: reference procedure of training exists
	• Records of the training are maintained.	Relation: reference artifact of training records exists
Audit Procedure	• Auditors are provided with written procedure	Entity: artifact of procedure documents exists
Audit Plan	• Audit interval	Entity: process element of time control defined
	• Role who creates this schedule	Entity: agent exists

Table 4 ISO 9001 requirements and check rules

5. Implementation and Summary

Unlike other ISO-supported environments, ISOCARE provides not only an application to facilitate generation of documented procedures but also an environment to enact these procedures. An ISOCARE prototype has been implemented. It is constructed based on a network-centralized PSEE written in JAVA. In the same time, an ISOCARE library has been constructed based on a PSEE similar environment by Flowring co. Although our ISOCARE is not in practical use, the latter is lack of integrated tools still. Besides, with ISOCARE, companies can build their QMS over Intranet within their organizations and extend it to Internet easily.

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