The Strategy to Enhance the Effectiveness of Software Engineer Training Program in Taiwan

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ABSTRACT: *To enhance the competence of software industry, the Taiwan Government start to mechanism of training program for software engineer in May 2002. In the beginning, the software engineers were classified into 13 categories. Then, the capability requirement for each category was therefore defined as well as the training courses and materials were also established. Further more, the assessment system was set up to measure the performance for this updated training program. This paper presents the organization, task forces, and progress of this training program. Judging from the industrial point of view, this training program should enhance the competence of software industry in Taiwan although most of the task forces are still on going.*

1 BACKGROUND

The "Software Industry and Education Survey Group" organized by the Science and Technology Advisory Group (STAG for short) of the Executive Yuan in January 2002, visited India to study its software industry and engineer training program. During the tour, the group learned that in terms of software talents training, Taiwan has a lot to learn from India. For instance, a subject teaching pursuant to text, regardless whether subject is an academic formal education subject or an on-the-job training subject, is taught to students of varying aptitudes; but since subject mechanics are generally the same and training objectives are not clear enough hence students who complete the course manifest different standards. "On-the-job" training courses offer advanced subjects, however students need to quite their jobs or take a leave of absence to avail of training, as a result, employed software engineers lack the channels by which they may absorb or obtain new knowledge. Skill testing and assessment could not immediately reflect the changes of software technology, and upgrade the technical level and class of licenses and certificate. Furthermore, training courses are not integrated with assessments, hence, courses are unable to upgrade the ability of information software technical talents.

Therefore, the STAG conducted a workshop on "Upgrade Functions of Cultivation for Software Engineers in Taiwan" in May 2002, a task force of the "Information Software Talents Cultivation Promotion Group (ISTCPG)" under the "Science and Technology Talents Cultivation and Application Promotion Program" is proposed. After three months studies, the organization and function of ISTCPG is proposed and discussed in "Strategy Review Board Meeting". The conclusion of the meeting was approved by Executive Yuan in October, 2002.The program was started in January, 2003. The organization of ISTCPG is shown in Figure 1.

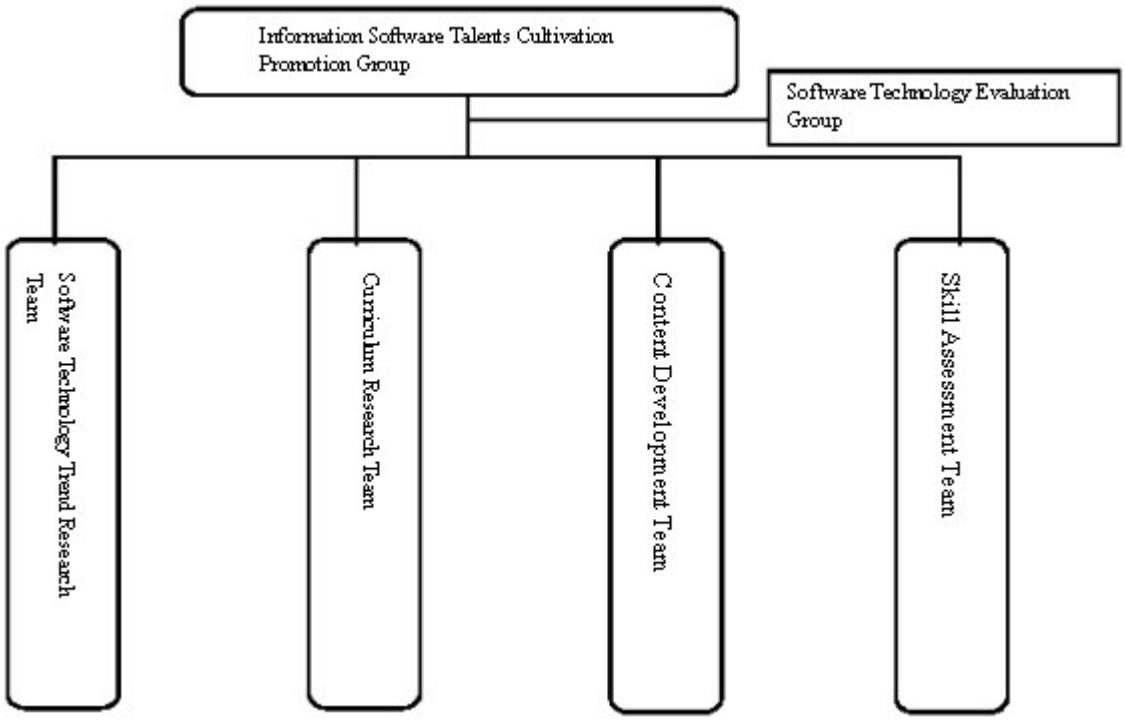

Figure 1. Organization structure of ISTCPG

The purpose of this paper is to present the organization, mission, and taskforces of the program. The organization of ISTCPG is described in section II. In section III, the classification for software engineer talents is introduced. The training curriculum of programmer, used as an example, is introduced in section IV. Finally, current situation of the program and the conclusion is made in section V.

2 THE ORGANIZATION AND FUNCTIONS OF THE ISTCPG

A. ISTCPG: The committee organized by executive secretary of the STAG and composed of experts and representatives of participating government agencies and associations; namely the Department of Industrial Technology, the Industrial Development Bureau, the Bureau of Employment and Vocational Training, the Technological and Vocational Education Department, the Taipei Computer Association, the Taiwan Electrical and Electronic Manufacturers' Association, Information Service Industry Association of ROC, the ROC Computer Skills Foundation, Chinese Society of Quality, and Chinese Software Quality Association. Its primary functions are to define the human resource training politics; to coordinate the tasks, procedures, and budget of various agencies; and to review the implementation result of each team.

B. Software Technology Trend Research Team: The committee was chaired by the Department of Industrial Technology (DOIT), Ministry of Economic Affairs. Its primary functions are to study the latest development trends of software development technology and present the studied result on the web; to investigate the technical status of Taiwan's software industries and compare results with those of other nations, and to publish the evaluation result on the "Software Technology White Paper" each year.

C. Training Curriculum Research Team: This team consists of two task forces: "employed engineer training" team and "technologial university and college curriculum research "team. The "employed engineer training" team is chaired by the Industrial Development Bureau of Ministry of Economic Affairs. It primary functions investigate the human resource needs of the software talents in Taiwan; to define the types of software talents; to define the core knowledge needed by each software talents type; to define training courses pursuant to the required software knowledge; to study the objectives, curriculum, class hours, and trainee qualifications of each training course; and to define the skill assessment method and minimum requirement for each type of talents. The "technological university

and college curriculum research team" is chaired by the Technological and Vocational Education Department of Ministry of Education. Its primary functions are to analyze the current curriculums and teaching practices of the information related departments of technical college, to investigate the employment problems of college graduates, to design the new curriculum based on the core knowledge requirement by a programmer, to design the syllabus for each course.

D. Content Development Team: The team is chaired by the Industrial Development Bureau of Ministry of Economic Affairs. It primary function is to develop e-learning material for the course defined by the Training Curriculum Research Team. The training material can be imported from other countries and developed by local companies.

E. Skill Assessment Team: This team is co-chaired by the Industrial Development Bureau and the Bureau of Employment and Vocational Training. The major tasks of this team are to establish and maintain the question database for the skill assessment of each course, and to execute assessment of software talents. The Bureau of Employment and Vocational Training conducts the programmer and computer application personnel skill testing procedures; whereas the Industrial Development Bureau conducts the assessment procedures for other human resource types.

F. Software Technology Evaluation Team: The team is chaired by the STAG of the Executive Yuan. The team members are university professors and industrial exports invited by STAG. It primary functions are to evaluate the work plan and result of other teams, and to propose new policy and new issues to ISTCPG.

The relationship of these six tasks is shown in Figure 2.

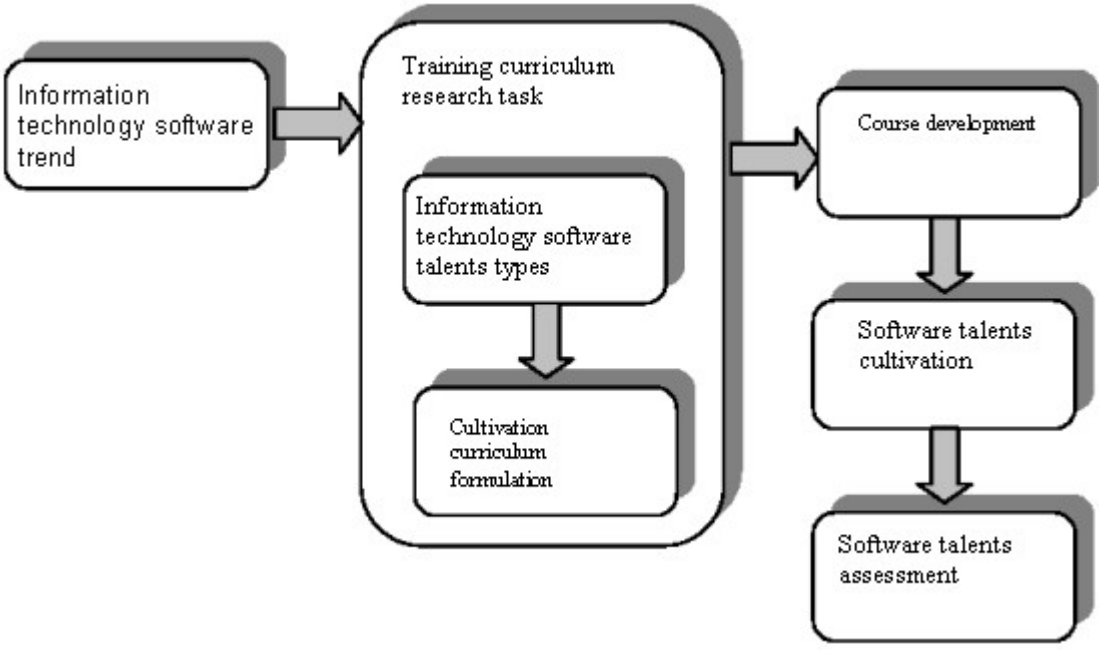

Figure 2: Information Software Talents Cultivation Strategy

3 CLASSIFICATION OF SOFTWARE ENGINEERS

Based on the different job functions proposed by the industries, thirteen types of software engineers, as shown in Fig. 3, are defined. To promote the computer usage skill of general users, 3 types of application users are also defined.

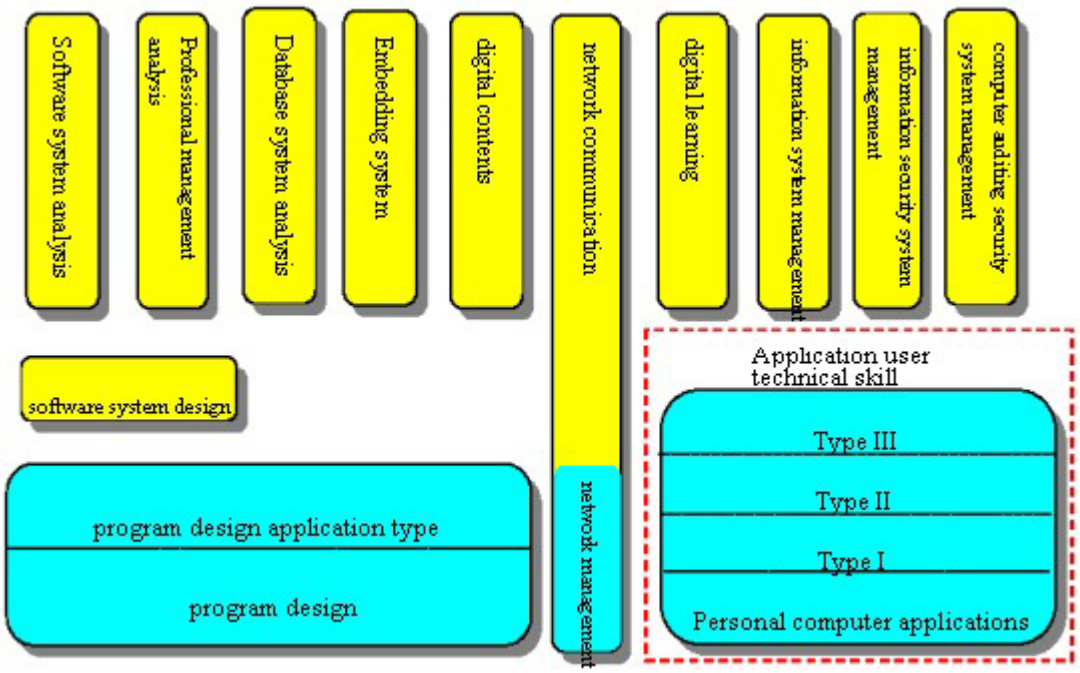

Figure 3. Classification of Software Engineers

More and more small and medium enterprises (SME) use computer to do their business, however, they have difficulties to verify the computer skill of their employees. If the candidate has the certificate to show his/her computer skill, the top management of SME will be easy to verify whether the candidate meets the job requirements or not. So the computer skill framework for general users is defined as three types. Type I user can use computer to do some basic work, such as using internet, sending e-mail, using word professor, etc. Type II user can use the common-use software packages in their professional area. Type III user has the capability to manage the computer systems of a small enterprise, such as reporting the computer system problems to service companies, solving some problems of printers and servers, etc.

Since different software companies have different business area, it is difficult to define the detail skill framework to satisfy all software companies, Based on their major engineering activities, all software engineers are classified into thirteen types. The skill framework of each type of software engineer consists of the following items.

A. Role
   The function of the software engineer is briefly described.
B. Job Description
   Each technical job the engineer should be done in the software company or computer hardware manufacture company is described.
C. Core Knowledge
   The required core knowledge to do the technical works described in Paragraph B is detail described.
D. Training Curriculum
   Based on the core knowledge defined in paragraph C, topics the engineer should be learned are defined. All topics are classified into several courses based on the relationship.
E. Assessment Criteria
   How to verify the core knowledge the engineer should have is detail defined. The test method and weight of each knowledge are also defined.

The above skill framework defines the core knowledge of each type of engineer should have. Based on the proposed training courses, an engineer will find a way to enhance his knowledge in order to move to high rank job.

Since technical knowledge is changed very fast, the proposed skill framework will be reviewed and refined each year.

4 SKILL FRAMEWORK OF PROGRAMMER

The programmer is the basic status of all types of software engineers;carrier development roadmap of software engineer is defined as shown in Fig. 4. The skill framework of programmer is described as follow.

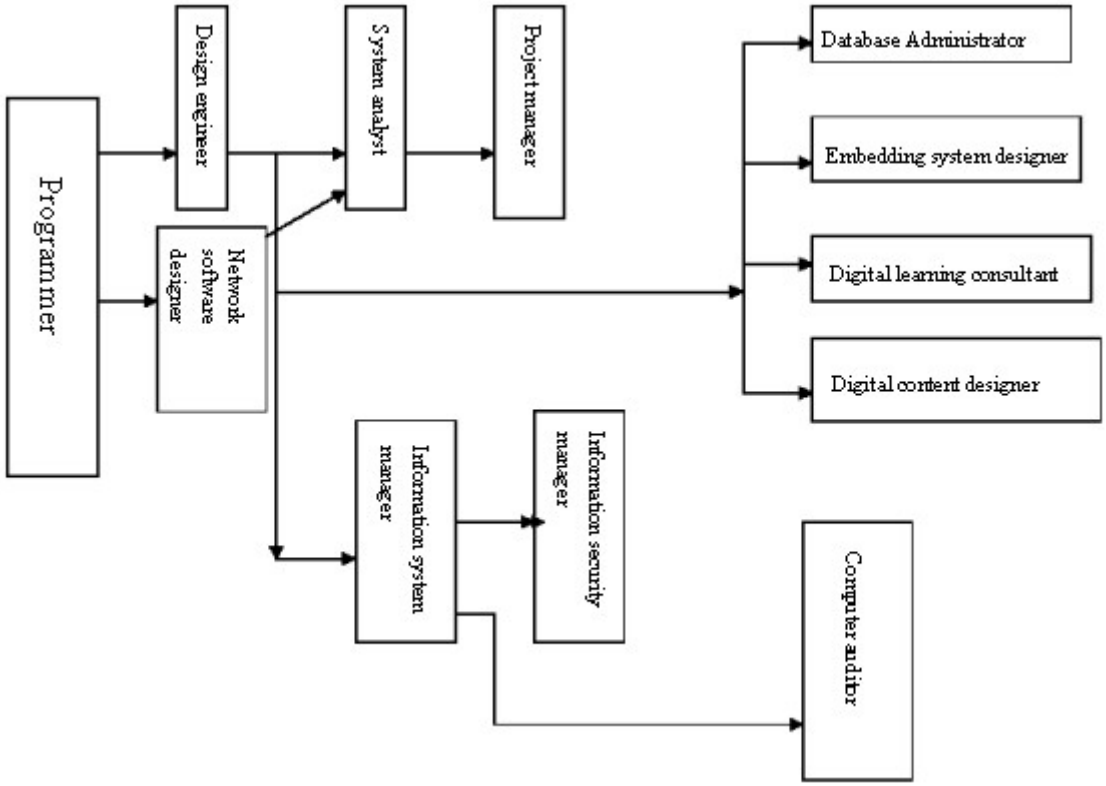

Figure 4. Carrier development roadmap for software engineer

(A) Role

The duty of a programmer is to write program modules, test program modules, and execute other software development work under the supervision of the software designer.

(B) Job description

1. Component design (internal design): assisting in the designing of software components; assisting in the designing of the database; producing and verifying software prototype; assisting in the designing component test specifications; and reviewing software component designs.

2. Detail design: designing detail algorithm of program module, designing program module test specifications, and assisting in writing the user's manual (final version)

3. Program writing: writing program codes; attending the peer review of program code, module testing, component testing, system testing, and software packaging.

4. Software Installation: assisting software installation, acceptance testing, user training and other technical support work.

5. Software testing: assisting test planning and designing test procedure, and executing testing.

(C) Core knowledge

1. Basic software knowledge: includes all application system design related general knowledge, such as general knowledge of software, hardware, network, and security.

(1) Basic computer concepts: basic hardware concepts, operating systems, middleware, evolution of computer architecture, multitasking, multi-threads, multiprocessor concepts, executing environment concepts, intellectual property right concepts and related laws, legal background in computer data confidentiality and privacy right, and computer worker professional ethics.

(2) XML: goal, symbol, and core concepts, link resources, page allocation, document model, conversion, etc.

(3) Network communication concepts: transmission media, network topology, communication protocol and standards, network installation, network management support, network security.

(4) Information security concepts: types of security threats, information security standards and regulations, authentication, information encryption.

2. Basic software development knowledge includes general knowledge and technique in the development of software system

(1) Software life cycle model: software life cycle; the concepts and comparative study of the strengths and weaknesses of all commonly used software system development models.

(2) Object-oriented concepts: software components, class and object, attributes, operation, methods, messages, packages, inheritance, polymorphism.

(3) Program language structure: names, scopes, and bindings, control flow, data type, sub-program and control abstraction; construction of executable programs, data abstraction, and parallel execution.

(4) Man-machine interface programming: the significance of man-machine interface; characteristics of image and Web man-machine interface, man-machine interface programming guidelines.

(5) Net-Centric Computing: introduction of Net-Centric Computing, Web examples: Client-Sever Computing, Web application programs.

3. Software quality.

(1) Basic software quality concepts: software process, CMMI, PSP, and TSP.

(2) Software test strategies and techniques:

- Software testing strategies: unit tests, integrated tests, software verification and validation, system tests
- Software testing techniques: code review, white box testing, black box testing, safety test
- Testing documents: test plan, test cases, test report.
- Debugging techniques: bugs management concept, debugging method, debugging tool.

(3) Software Documents

- Pseudo Code, Coding Convention.
- Software document types, software document formats.

- UML: user case diagram, class diagram and object diagram, sequence diagram and cooperation diagram, state diagram and activity diagram, component diagram and deployment diagram, interface, collaboration, extension mechanism, frame, and template.

4. Data structure and algorithms

(1) Data structure: stack, queue, list, tree, graphs

(2) Algorithms: basic problem solving approach, recursion application, sorting and searching, hashing technique.

5. Database design (should especially focus on SQL command writing skills and database program document reading skill).

(1) Database system concept: structure and application of all types of files, data models, database system framework

(2) Relational Database system: Relational Database model, Structured Query Language (SQL), vision, stored procedure, trigger procedure, transaction management.

(3) Relational Database design concepts: entity-relation model, logic database design, physical database design

6.Program language

Programmers should be familiar with at least two programming languages, such as JAVA, C++, Visual Basic, or Delphi.

Furthermore, programmers should have the good working attitudes and management skill, such as communication skills, leadership, team spirit, etc. This part should be conducted through doing team project during and training.

In addition to the required core knowledge, software programmers should also have the domain-specific knowledge required for a certain application area type. Such knowledge or technology could be taught during training, or incorporated into the programmer's pre-job training program. Such knowledge includes database application knowledge, IA application knowledge, web-base application knowledge, game software design knowledge, etc.

(D) Training courses

The training courses based on the core knowledge as defined as follow:

1.Basic course

(1) Introduction to software environments

(2) Introduction to software development

(3) Software quality

(4) Data structure and algorithms

(5) Basic database applications

(6) Program language□Java

(7) Program language□C++

(8) Program language□Visual Basic

(9) Program language□Delphi

(10) Customized production

2. Java series advanced courses

(11) Java database application and software component programming

(12) Java Web Application Client terminal programming

(13) Java Web Application Server terminal programming

(14) Java and XML application programs

(15) J2EE deliberation

3. Microsoft series advanced courses

(16) MS Web Application executing environment

(17) MS Web Application Client terminal programming

(18) MS Web Application Server terminal programming - basic

(19) MS Web Application Server terminal programming - advanced

5 CURRENT STATUS AND CONCLUSION

A. Current status

Until now, the following tasks has been completed:

(1) The skill framework of thirteen types of software Engineers

(2) The training programmer's content

(3) Assessment database of programmer

(4) Programmer-related curriculum for technology university

(5) Software technology white book

(6) Ten e-learning courses contents for programmer training

B. Conclusion

In knowledge economic ages, computer is widely used in government and enterprises. The demand of software increases very fast, that means software industry is getting important to a country. To enhance the competence of Taiwan's software industry, the software engineer's training program is reengineered in Taiwan since January, 2003. A brief introduction of this project is presented in this paper. Education is a long-term job, it is no easy to get sound result in a short period. However, from software industry viewpoint, this program will give much help to them. So we are happy to share our experience with other countries.