Skill Transfer from Expert to Novice – Instruction Manuals Made by Means of Groupware

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Abstract. Modern manufacturing industry changes dramatically following the fast progress of mechanical improvement and informatics development. Young people focus on learning new techniques in order to catch up the fast progress. Traditional industrial skills are missing step by step that will be a problem for modern industrial manufactures. The technological generation gap also causes damage in manufacturing industry. Elder experts who accumulated many traditional industrial skills faced the problems of retirement and strict competition. Young novices receive modern industry technique trainings, but still require traditional skill to maintain the industrial manufacture. The skill transmission from elder expert to young novice is known as an important course. In Japan, industry pays a lot of concern at the decline in mastery of skills technology. Based on the importance and difficulties of skill transmissions, an idea model was searched and established in this study. We choice screw manufacture as a representative industry in this study because screw manufacture required traditional skills and modern techniques. A manual introducing traditional skill and integrating computer science could transmit technologies smoothly from elder expert to young novice. Computer science here is used to link generation gap, to introduce traditional skill delicately in order to keep all the detail tricks and lively in order to be accepted by novice. The transmission efficiency and efficacy both will be considered.

1 Introduction

20th century is entering into information age step by step. Mechanization industry is followed this changes. During these changes, novel mechanized techniques in the production line are especially important in manufacture industry. In Japan, industry moves abroad seeking cheap manpower after the establishments of mechanized techniques. This phenomenon causes some problems during manufactory skill conservation in Japanese manufactory industry, such as skill transfer gap from expert to novice and traditional skill gradual loss. There are some problems make the skill

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M.J. Smith, G. Salvendy (Eds.): Human Interface, Part II, HCII 2007, LNCS 4558, pp. 423–429, 2007.

transfer more difficult, named as the aging of society, young people transfer their job from time to time and the main company and its manufactory field are distantly separated. According to this concern, an organization processes should be produced in order to make the skill conservation smooth including the success transfer from information to knowledge, from concept to language, from hand operation to manual. Based on this proposal, it might be possible to decrease the gap as well as industry risk through a series of organization processes, including integration the various skills into knowledge, making obscure concept into language, combining the individual skills into systematic procedure and consulting the above into protocol after modification by expert and novice several times.

Based on the above considerations, some strategies are claimed to solve the skill passage problems in production line in manufactory field. Here shows the strategies in the screw manufacturing industry to establish a model to transmit expert skills to young beginners in the production line. The efficacy and deposition of conversion from beginning introduction to the ending termination through operating guider is discussed in this paper.

Traditional operation guides were written by expert alone to list the manufacture technique procedures (personal technology formula). In this kind of operation manual, individual's cognitive difference causes the manual difficult to carry by beginners or other workers. Here present a technology conversion method to transmit personal technology formula into a organized technology transduction. All personal technologies will be guided into SECI model through socialization, externalization, combination and internalization.

2 From Knowledge to Manufacture Process

Knowledge can be grouped depending on its creature characters, one is tacit knowledge which is hard to express into language and the other is explicit knowledge which can transmit to others easily through formula. Figure 1 shows four transmission procedures. 1. Socialization: Integration the tacit knowledge from individuals through common experience. In this step, the knowledge conversion is from tacit knowledge to tacit knowledge (Shown in figure1). 2. Externalization: transmitting the tacit knowledge into explicit knowledge by using charts, tables and figures. In this step, the knowledge conversion is from tacit knowledge to explicit knowledge. 3. Combination: linking the individual explicit knowledge together into organized set. In this step, the knowledge conversion is from explicit knowledge to explicit knowledge. 4. Internalization: solidify the organized knowledge set into manufacture production line through small experimental production group. In this step, knowledge conversion is from explicit knowledge to tacit knowledge. The integration of those 4 steps here is so shortly called SECI model using their first letter. Three of the four types of knowledge conversion, named socialization, combination and internalization, have been discussed from various perspectives in organizational theory. For example, socialization is connected with the

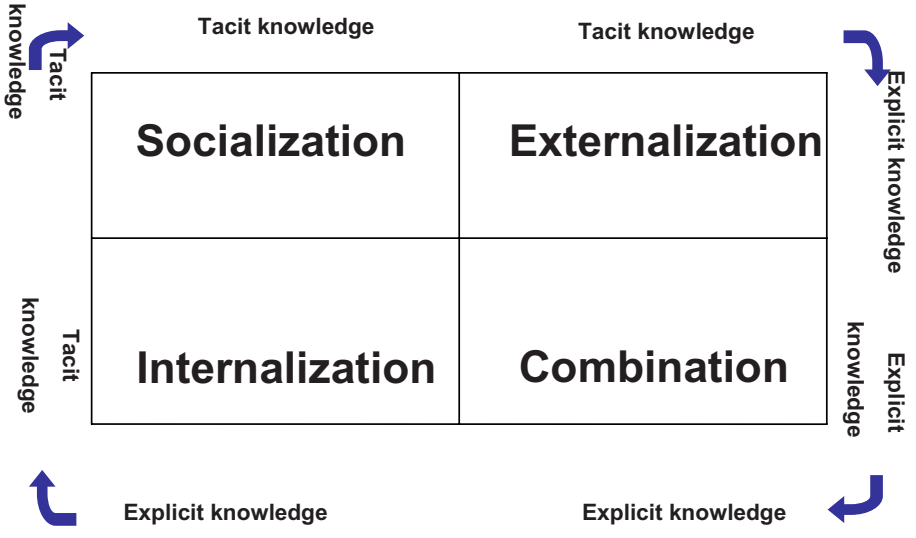

Fig. 1. Four models of skill conservation from tacit knowledge to explicit knowledge. The four steps are socialization → externalization → combination → internalization. The four steps will be modified by experts and novices through several circles. After modification, the mature protocol will be gained in order to conserve the expert's skills in manufactory fields.

theories of group processes and organizational culture,; combination has its roots in information processing; and internalization is closely related to organizational learning. However, in this three step model, externalization has been somewhat neglected. In our theory, we add externalization to help knowledge conversion from tacit knowledge to explicit knowledge smoothly.

3 Protocol Outline Analysis

Protocol analysis is a psychological research method that elicits verbal reports from research participants. Protocol analysis is used to study thinking in cognitive psychology, cognitive science and behavior analysis. It has found further application in the design of surveys and interviews, usability testing and educational psychology. In this SECI model, the protocol is firstly recorded through language individually. Individual protocol will analyzed their similarities and difference to express into an organized protocol.

4 Software Grouping

Grouping software means a computer interface can integration various data, thus to establish a data bank. This computer systematic data bank supports the users of similar

goals with a common computer interface to analyze systemic data. This study use Lotus Notes as grouping software belonging to Lotus Development Company. Figure 2 shows the transmission routes by using Lotus Notes.

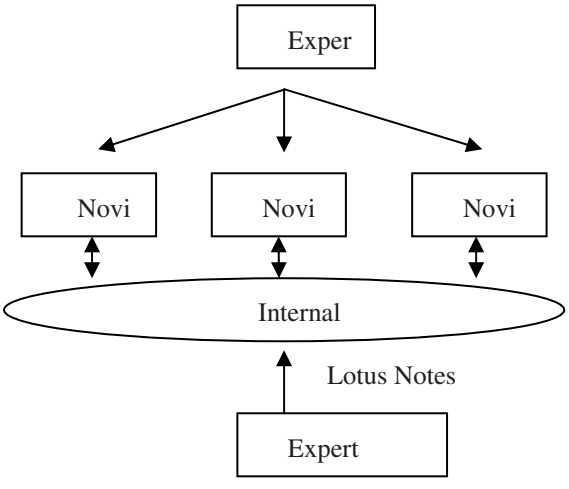

Fig. 2. Knowledge conversion is shown here by using Lotus Notes

5 Technology Transmission Using SECI Model

Figure 3 shows to transmit technology through SECI model. Four procedures are used as mentioned above – socialization, externalization, combination and internalization. All individual expert's experience and skills are integrated and externalized into common protocol guideline. Real practices and experiments will be carried under this common protocol guideline. The technology transmission procedures will be listed below:

Investigation of expert's technology
↓
Technology analysis and integration into knowledge
↓
Protocol guideline production
↓
Actually operation using protocol guideline

5.1 Inveatigation of Experts' Technologies

In this step, Notes software is used to investigate the expert's technology during manufacture production line and their technologies will transmit into Notes formulae. Recording by speech or video during the experts presenting their skill both can be used in those investigations.

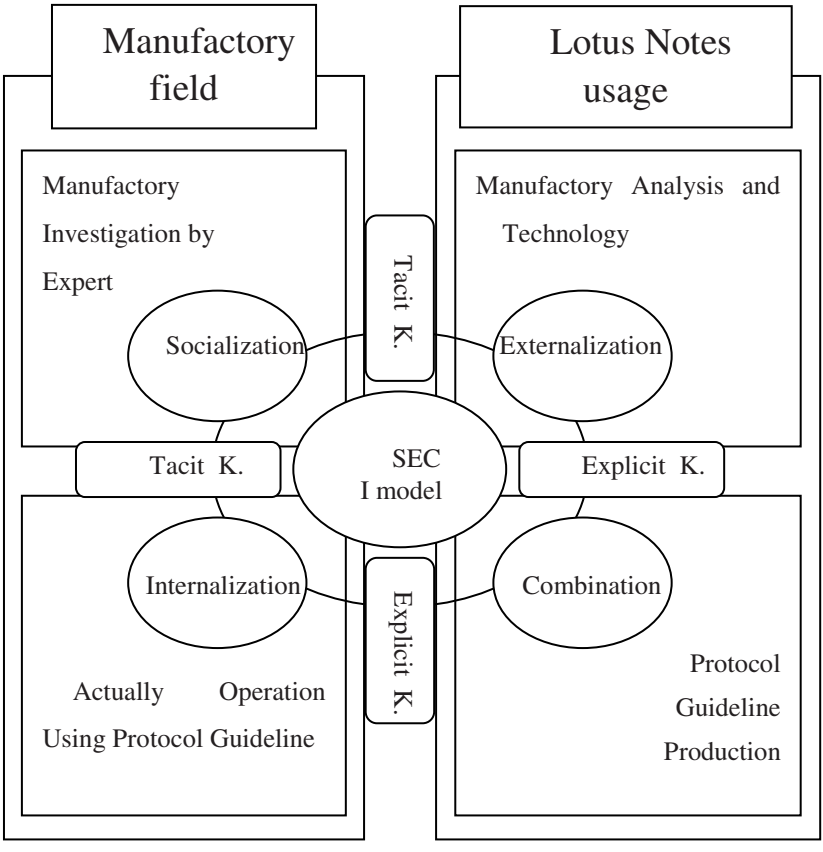

Fig. 3. Technique conservation uses SECI model. Technique knowledge will be conserved through tacit K. (knowledge) to explicit K. (knowledge) by SECI four steps round and round.

5.2 Investigation Analyses and Transmission from Technology into Knowledge

Transmitting technology into knowledge using words, lectures, or pictures is an important procedure of externalization. Sympathized knowledge about consumers' wants may become explicit conceptual knowledge about a new-product concept through socialization and externalization. Such conceptual knowledge becomes a guideline for creating systemic knowledge through combination. A new-product concept steers the combination phase, in which newly developed and existing component technologies re combined to duilf a prototype. Systemic knowledge turns into operational knowledge for mass production of the product through internalization. Experience-based operational knowledge often triggers a new cycle of knowledge creation. The users' tacit operational knowledge about a product is often socialized, thereby initiating improvement of an existing product or development of an innovation.

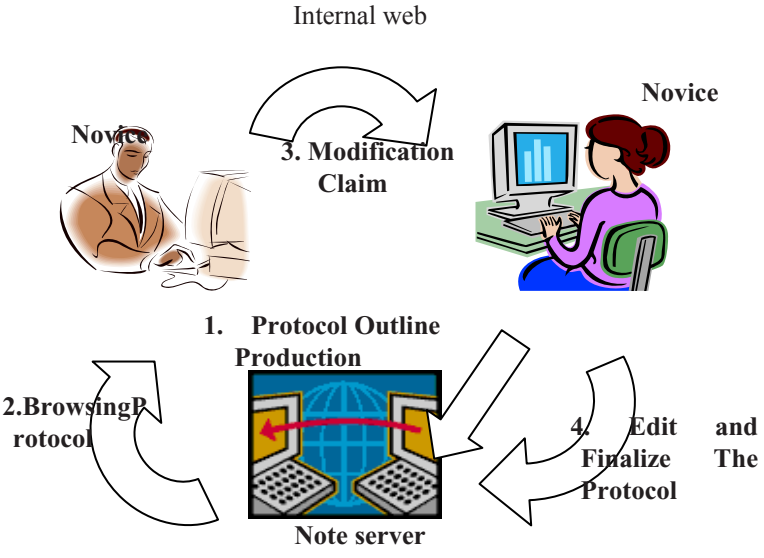

Fig. 4. The procedure of modification and editing the protocol outline divides into four steps. In the 1st step, the expert will write a brief manufactory protocol by using Lotus Note. A server is established based on this purpose. In the 2nd step, the novice will browse the brief protocol by using the internal web. The novice will go through reading and claims some questions in the 3rd step. The expert will edit the protocol in the 4th step. After 1st circle, the edited protocol will pass to novice in the 2nd step of the 2nd run. The circle will repeat till the novice can understand the protocol, then operating themselves. After actual operation, novices will claim new questions and expert will edit the protocol till the mature and final protocol done.

Discussion is especially important during these processes. Communication through email might be a good way since web is very popular and the email can be kept and used in the later steps.

5.3 Protocol Guideline Production

After externalization, the techniques are recorded into digital formula. The protocol guideline will be produced and modified as followed:

Step 1: As shown in figure 4, not only experts but also beginners must participate the integration and production of protocol guideline. The editor will collect the original information and discussion from experts and beginners as a basis to list the data into Lotus Notes software that can be integrated later.

Step 2: The beginners must browsing on all the information on Lotus Notes to help editor to improve the data bank of Lotus Notes.

Step 3: The editor will collect the original information from beginners and checked by experts. Beginners will claim the modification when carries their works based on the protocol recommend by expert.

Step 4: Repetition from step 2 to step 3 is necessary till no claimed modifications.
Step 5: Experts will aid the beginners to make products through protocol guideline. During this process, the beginners will modulate the protocol and then expert will correct those modulations.
Step 6: Experts will point out the improvements in protocol guideline after checking the beginner's production and review the protocol guideline. Then, the beginners will modify the protocol guideline again.

5.4 Protocol Guideline Modification Through Operations

In the process to produce protocol guideline, the beginners become successors. The externalized knowledge will internalized as self knowledge to those successors. Now the technology passage is successfully done. There is one case of screw manufactory in Japan, the expert cost 151 sec in SECI circle and the beginners cost 1421 sec to produce a final protocol guideline.

6 Inspection and Limitation

Some limitation will occur when using SECI to produce final protocol guideline. Discussed below:

1. The limitation of technology externalization

Some techniques are difficult to express in language, especially some skill by using figures or body movements. Those difficulties cause limitation.

2. The limitation of Transmission limitation

Experts are familiar with their techniques but not expressions. Some gaps will be occurred during transmissions.

3. The limitation of un-transmissible techniques

Some techniques is characterized as difficult to transmit. It is very difficult to transmit some screw productions no matter using a lot of time and transmission procedures in the screw manufacture industry. The real operation will be necessary in those cases. In those cases, real operations will help the technique transmissions.

7 Conclusion

This study introduces a SECI model to transmit technology into knowledge step by step. All the technologies, possible externalized, can be integrated into knowledge to be transmitted from generations to generations, from experts to beginners. The training of successors of traditional skills is very important in aging and informatical society. This study will help the transmission of technologies easier and more efficacy.

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