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A Supporting System for Knowledge Creation Process

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Abstract

A knowledge management system, Knowledge Management System for Scientific Research Group (KMSSRG) is designed to facilitate knowledge creation within a scientific research group. Implementation issues of such a system are analyzed and discussed in this paper. The main feature of the KMSSRG is the support of Internal Knowledge Evolution Network (IKEN). We developed the IKEN by (1) using Ikujiro Nonaka's SECI model to identify core sub-processes and related knowledge that are keys to knowledge creation, and (2) analyzing carefully the knowledge creation process for both individuals and teams. As a result, IKEN is a directed network that maps knowledge (both implicit and explicit knowledge) fragments created by different team members in various research activities. Context reference relationships among these knowledge fragments can also be represented.

1. Introduction

Nowadays universities professor often does scientific research in groups with other professors and students. They need to share information between each other through the whole knowledge creating process. Although IT tools such as FTP, BBS, mailing list and Web site provide communicating of information, and the university library systems provide sharing of publications, the functions they provide are the same for groups as for any individual researches, with no outstanding effect on the efficient management of the valuable tacit knowledge that key to group knowledge creation. Both IBM Lotus and Microsoft released Knowledge Management Systems "maintaining a central knowledge database which keeps all the information of the team project including documents, contactor, mission, discussion"[1], but pieces of knowledge and their context reference are hidden inside the files "heaped" at the database waiting for "dug". In this paper we designed a system that can support Internal Knowledge Evolution Network (IKEN) which is a directed network that maps knowledge created by different team members in various research activities. With this system both implicit and explicit knowledge could be retained and the context reference relationship among the knowledge fragments could be easily traced.

2. Method

To design the support system we studied the formats of and the interaction between knowledge fragments in knowledge creation process. We started by subdividing the process into four stages according to the sequence of common researching: reference searching, reference reading and studying, topic researching, summarizing and paper drafting. Although each stage may go backward and intertwined with each other, we retain this subdivision for easy of discussion.

Then by applying Nonaka's concept of tacit/explicit knowledge and SECI model[2], we discussed what characteristic is of each stage knowledge and how tacit knowledge transforms into explicit knowledge, and how one's knowledge interact with the other's.

2.1 Nonaka's concept of tacit/explicit knowledge and SECI model

In Ikujiro Nonaka's study, the knowledge creation process is the conversion process between tacit knowledge and explicit knowledge [George Von Krogh, Ikujiro Nonaka, Toshihiro Nishiguchi'2000]. By his definition, explicit knowledge can be expressed in words and numbers and easily shared. Tacit knowledge, such as subjective insights or emotions, is non-articulated, and embedded in contexts and actions. It is personal and hard to verbalize or communicate. Tacit knowledge, such as bodily skills or mental models, is rooted in an individual's action and experience as well as in the ideals or values he or she embraces.

In the SECI model, the knowledge creation process within an organization takes a spiral evolution form, which consists of four types of conversions (figure 1). Socialization is the process of sharing the tacit knowledge of individuals. Externalization requires the articulation of tacit knowledge and its translation into forms that can be understood by others. Combination involves the conversion of explicit knowledge into more complex sets of explicit knowledge. Internalization means the conversion of newly created explicit knowledge into the tacit knowledge of individuals.

The model can better explained using the famous 'bread machine' case as follow:

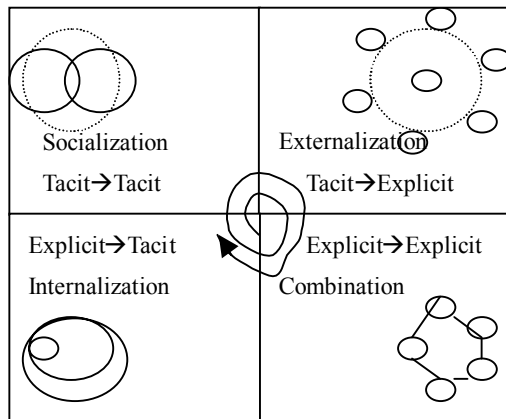


Figure 1. Nonaka's SECI Model

- Ms. T went to the famous bread baker to learn how to make the first-class bread by hand. The socialization conversion was implemented when the tacit knowledge of the baker was learned by Ms. T and remained tacit form in Ms. T.
- Ms. T shared her knowledge with her fellow workers by telling out the skill. The externalization conversion is implemented when the skill conveyed to the fellow workers in words.
- The group members worked together sorting out the knowledge and implemented the coding in the program of bread machine, the combination conversion is implemented when the knowledge is edited in systematic digital format.
- Then the machine along with its coding knowledge was accepted by other persons, the internalization conversion is implemented when the knowledge changed into tacit knowledge in the form of individual experience.

2.2 Basic processes for individual

To analyze the basic processes for individual, we list the content of both tacit and explicit knowledge (Figure 2), and discuss the transformation between tacit and explicit knowledge as that of SECI model.

Basic stages	Searching	Reading and Studying	Researching	Summarizing and Drafting
Explicit Knowledge	Publications such as papers, books	Comments on published works	Confirmation, Proof, Refutation	Papers, reports
Tacit Knowledge	Not remarkable	Problems, Suppositions	Advanced problems, suppositions	Not remarkable
Conversion		Explicit to Tacit	Tacit to Tacit	Tacit to Explicit

Figure 2. knowledge format and conversion

- In the searching process, the outside public knowledge resource are collected. The knowledge is in explicit form that stored in the published papers, books, or reports.
- In the studying process, both tacit and explicit knowledge are produced during the studying of outside resource. The explicit knowledge are comments or remarks on the published works, which are the externalization result of the personal internalization of published knowledge, a process of explicit → tacit → explicit. The tacit knowledge are embodied on guess and/or supposition to the solutions for project problems, which are subconscious imagination based on exist knowledge and personal experience. They are very obscure and not easy to be described concisely, and are often expressed with the aid of analogy or metaphor. They are of explicit/tacit → tacit process, and are the precursor of knowledge creation.
- In the researching process, both the tacit and explicit knowledge in studying process are further improved, with tacit knowledge develop into explicit knowledge, and with new tacit knowledge spring from existing explicit or/and tacit knowledge. For the tacit → explicit, the guess or supposition that can be testified are briefly proved in draft, which consist of set of knowledge fragments that will be systemized into new knowledge. For the explicit/tacit → tacit, new guess and/or supposition are continuously brought up based upon existing knowledge and personal experience.
- In the summarizing process, the fragments of research results are edited into systemized explicit knowledge, which is of explicit → explicit process.

2.3 Basic processes for team

Communication and interaction characterize team work. The exchange of opinions brings change to both the tacit and explicit knowledge. By observing the content of exchange and the transformation of knowledge, we can identify the core processes that are key to team knowledge creation. See table 1.

Table 1. the content of exchange and the transformation of knowledge in a team work

Basic processes	Types of knowledge	Content of exchange	Transformation of knowledge
Searching	Explicit	Information on the resource	
	Tacit	None	
Studying	Explicit	Comments or remarks on published works, as well as on exist comments	Accumulate: by sharing the study
	Tacit	Guess or supposition to solution of project problems, as well as comments on them	Accumulate: by sharing the insidious methods Knowledge creation: by provide new idea based on individual experience.
Researching	Explicit	Confirmation or proof to guess or suppositions, as well as comments on them	Accumulate: by sharing the proofs Knowledge creation: by jointly work on the same problems step by step.
	Tacit	More guess or suppositions, and more comments on them.	Accumulate: by sharing the insidious methods Knowledge creation: by provide new idea based on individual experience.
Summarizing	Explicit	Information on proof-reading	
	Tacit	None	

- In the searching and summarizing processes, the exchange focus on explicit information, such as the location of certain paper, or the proof reading of written draft.
- In the studying process, for the explicit knowledge, the exchange of comments or remarks on published works can speed up the accumulation of existing knowledge for each member. For the tacit knowledge, the exchange of guess or supposition diversifies the possible solutions, and arrests more attention on individual problem, which provide solid foundation for the next stage of co-work on attacking the problem.
- In the researching process, for the explicit knowledge, the exchange of fragments knowledge created help members to keep up with the current progress of project, and the insidious methodologies inhibit in the proof help to improve personal experience. For the tacit knowledge, more than one effort focus on individual problem. With the supplement of many efforts the power is amplified and the knowledge creation is accelerated.

2.4 Core sub processes

From table 1, we can see that the knowledge creation take place on studying and researching processes. Therefore, the studying and researching are core sub processes for knowledge creation. The knowledge

production can successively evolve in concord if the members can share both the tacit and explicit knowledge step by step, as seen in figure 3.

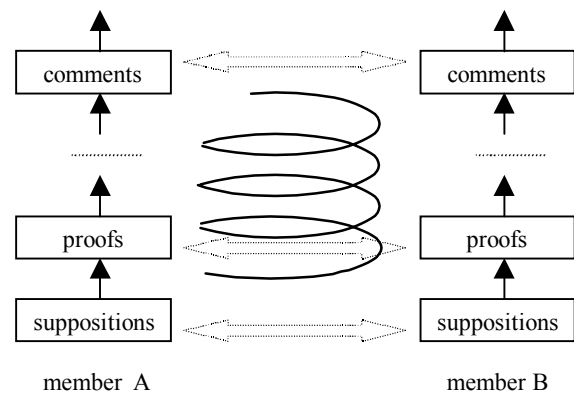


Figure 3 knowledge evolution in concord

3. Result

3.1 IKEN

And then we developed the concept Internal Knowledge Evolution Network to describe the knowledge evolution framework .

From the core processes identified in the above section, we can extract four types of knowledge.

- comments or remarks on published works
- guess or supposition to the solutions for project problems

- proof or confirmation on the guess or supposition
- positive or negative comments or remarks on knowledge 1-3.

These four types of knowledge increase in the process and are dependence on each other. When linking with their context relationships, the knowledge fragments created inside team construct a directed network map, as shown in the Figure 4. Along the direction of the arrows, pieces of tacit knowledge are continuously created based on previous knowledge, and converse to explicit knowledge. We define this network as '**Internal Knowledge Evolution Network**'.

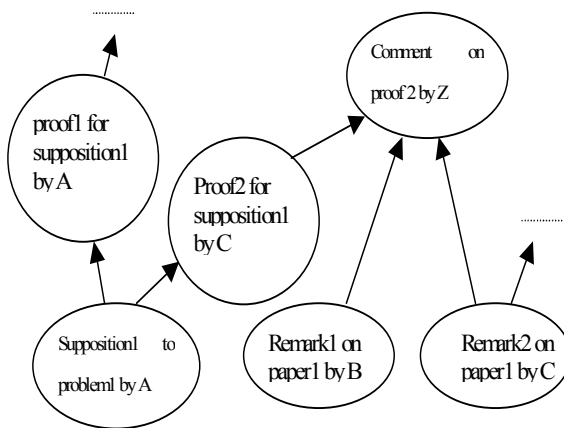


Figure 4 Internal Knowledge Evolution Network

3.2 IKEN discussion

IKEN describes the inside team knowledge evolution map, with the similar idea as that of citation index service which provides knowledge linkage between published works. Knowledge linkages, both within and out of team, are important in creating new knowledge, but the IKEN is much important since it embody the tacit knowledge of each team member. The public knowledge is explicit and easy to locate without the risk of losing, but for tacit knowledge, it is the resource of creation which can not

afford losing. Therefore, managing IKEN is key to manage knowledge creation.

In addition, following is a list of more advantages on managing IKEN:

- The progress of the research will not be stopped when someone leave. The personnel change used to be the most dangerous thing for project research. With the support of IKEN, the job can be easily taken over by other members, and new member can quickly keep up with the progress.
- Virtual team can be better supported with digital IKEN which makes the members free of location.
- Cooperation and communication obstacle caused by culture conflict or different habit can be overcome, since the digital IKEN provides more possible ways of exchange.

4. A Knowledge Management System for Scientific Research Group

From the previous analysis it's obvious that IKEN contains the tacit knowledge of the group. We devised a Knowledge Management System for Scientific Research Group – KMSSRG which can support IKEN..

In designing system we included other explicit knowledge resource such as books, papers, reports as the bottom layer of the knowledge (figure 5). One piece of knowledge may refers to multi-pieces of knowledge, and one piece of knowledge may be the reference of multiple pieces of knowledge.

Acknowledgement

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Reference

- [1]<http://www.Microsoft.com>
- [2]George Von Krogh , Ikujiro Nonaka , Toshihiro Nishiguchi, *Knowledge Creation : A Source of Value*, Palgrave, 2000

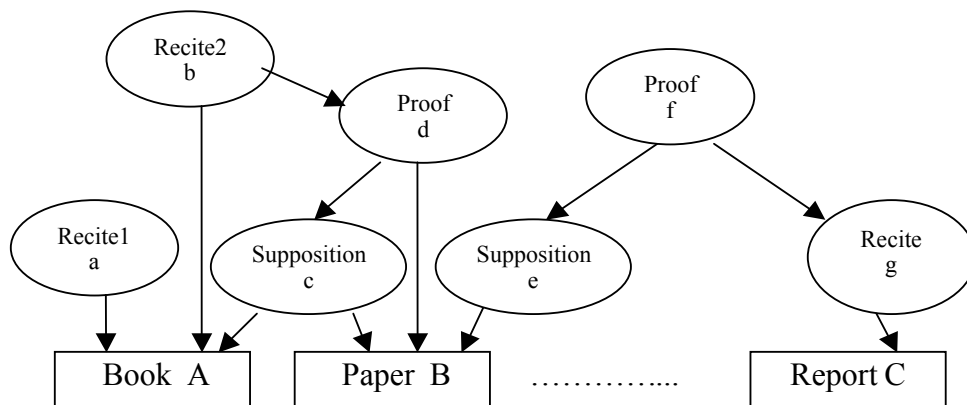


Figure 5 Extending IKEN by adding books, papers as bottom layer