# THE RESEARCH OF KNOWLEDGE MANAGEMENT SYSTEM FOR SUPPORTING HYPER TEXT TYPE OF ENTERPRISE ORGANIZATION

Masaru Iguchi[1] and Yoshiyuki Kotani[2]
[1] *Department of Computer and Information Sciences, Tokyo University of Agriculture and Technology, Tokyo, Japan*
[2] *Institute of Engineering, Tokyo University of Agriculture and Technology, Tokyo, Japan*

Keywords: Knowledge Management, Document, Hypertext, Organization, Ontology.

Abstract: In recent years, many enterprises have used knowledge in their management. Due to globalization, the organizational structure of enterprises is trending towards integration of the conventional bureaucracy type with a "Hyper Text type", in which the organization is formed for each project. Such structural change brings a need to also change the knowledge management of enterprises. This paper defines enterprise knowledge as documents, and proposes a document search system which suits the above "Hyper Text type" organization.

## 1 INTRODUCTION

Many enterprises consider the use of knowledge in their management to be increasingly important. On this point, the Organization for Economic Co-operation and Development (OECD) claims in its report "The Knowledge-based Economy" that "Knowledge is now recognized as the driver of productivity and economic growth." This clearly indicates the importance of knowledge in economic activities (OECD 1996). Enterprises which develop and mass-produce industrial products especially need to invest a large amount of money in research and development, and consider knowledge as an asset. On the other hand, in activities of such enterprises, the time interval from launching a new product to the next has been shortened. For a project to develop a new product according to the shorter time interval, one or two members are selected from each division (development, purchasing, production, sales, etc.) to form a taskforce. While the taskforce members belong to their own divisions, they work for the project until it is completed. Nonaka and Takeuchi considered this organizational structure a "Hyper Text type" organization, and took Japanese enterprises which aimed to integrate bureaucracy with taskforces as examples for their study (Nonaka and Takeuchi, 1995). This paper defines knowledge as documents that express knowledge, and discusses a system that supports document management for the enterprises which have the above "Hyper Text type" organization. First, relevant studies are presented in Chapter 2. The outline of the document management system in the "Hyper Text type" organization and an overview of the proposed document management system are presented in Chapter 3. The conclusion of this paper and future study themes are described in Chapter 4.

## 2 RELATED WORK

### 2.1 Knowledge and Enterprise Organization

Accumulating as knowledge the developmental abilities which demonstrate the strength of enterprises has been increasingly important for the competition and success of enterprises. Consequently, improvement to the traditional, organizational structure, namely bureaucracy, is considered necessary. However, instead of eliminating the bureaucracy, aiming for an organizational structure that is mutually complementary with taskforces is considered necessary. Such an organizational structure is the


Iguchi M. and Kotani Y..
THE RESEARCH OF KNOWLEDGE MANAGEMENT SYSTEM FOR SUPPORTING HYPER TEXT TYPE OF ENTERPRISE ORGANIZATION.
DOI: 10.5220/0003635403120317
In *Proceedings of the International Conference on Knowledge Management and Information Sharing* (KMIS-2011), pages 312-317
ISBN: 978-989-8425-81-2

"Hyper Text type" organization, which refers to "Hyper Text" originally developed in the computer science field (Nonaka and Takeuchi, 1995).

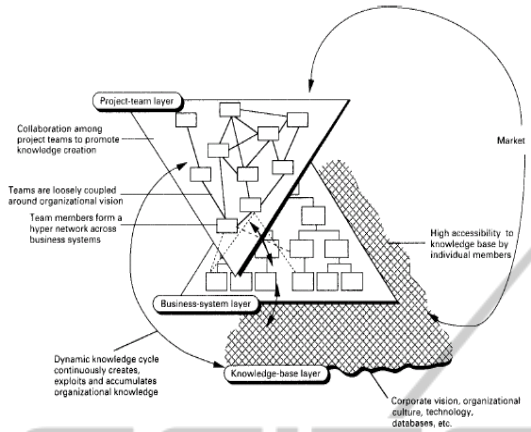


Figure 1: The hypertext organization (Nonaka and Takeuchi, 1995).

Figure 1 shows the "Hyper Text type" organization. The layer in the center of the figure is a business system layer in which normal routine work is done. As the bureaucratic structure is suitable for its efficiency, this layer is a hierarchical structure. The top of this structure is a project team layer, in which many project teams are engaged in product development and the like. Members of these teams are gathered from many divisions of the business system layer, and engage in one project until it is finished. When the team finishes the task, it returns to the knowledge base layer, draws up a knowledge inventory describing successes and failures of the project, and returns to the business layer. Based on his work experience at an enterprise where he worked, the writer thinks that even if the aforementioned knowledge is prepared, if the situation does not enable its reuse, in cases where part of the description needs revision or where another project team wants to refer to it, accessing the inventory is very difficult. Mainly using cases of European enterprises, Enkel and others proposed a knowledge network for the growth of enterprises consisting of three layers (Enkel, 2007). Those cases present a facilitating condition summarizing a management methodology practiced by enterprise management, a knowledge process regarding knowledge work by interaction among employees, and a reward structure and meeting methods and communication methods serving as tools to support the knowledge process. The framework designed by Enkel and others is a model to relate and comprehensively manage the business strategy with systems and tools that support the business process. However, this framework is different from an enterprise organizational structure which is the target of the system proposed in this paper. In addition to this, Duncan (Duncan, 1979) and Ackoff (Ackoff, 1989) advocate building relationships among data for intra-enterprise knowledge distribution, but both of these differ form the proposal of this paper in the intended organizational structure and the data link structure.

## 2.2 Knowledge Management System

In recent years, computerized documents and email have been used for in-house communication. In enterprises, in-house knowledge distribution based on a community called a "Community of Practice" (CoP) or "Community of Interest" (CoI) proposed by Wenger and others has been introduced into business management (Wenger, 2002). Here, CoP signifies a community where knowledge effective for business performance is exchanged, and CoI signifies an informal community where knowledge of wide interest to employees is distributed. Based on this principle, Lavoué proposed a model that connects produced knowledge to activities proposed by the CoP (Lavoué, 2009). On the other hand, Benjamins and others used techniques of ontology engineering in their approach to knowledge management systems (Benjamins, et al, 1998). The approach allows the discovery of knowledge that is not explicitly known but can be deduced based on general knowledge which is captured in the ontology). Figure 2 shows overview of the approach.

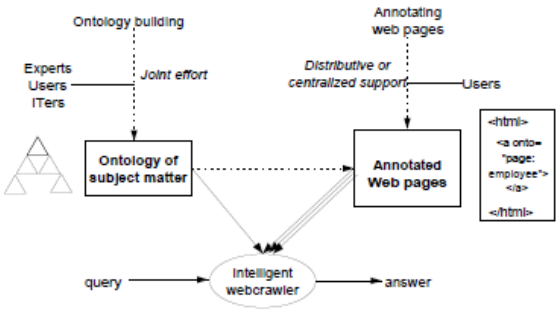


Figure 2: An Ontology-based approach (Benjamins, 1998).

An ontology of the subject matter must build, which is used to characterize the subject matter, for instance to fill the ontology with instances. A intelligent web crawler receives a query in term of the ontology, consults them using the ontology and generates an answer. Though the techniques of ontology engineering are applied to the proposed document management system described later in this

paper, the composition of document management is considered one of the ontologies in this paper. Thus this paper differs in that it does not newly define domain ontology, and in that a document itself is considered an instance.

# 3 OUTLINE OF THE PROPOSED DOCUMENT MANAGEMENT SYSTEM

In recent years, as a means to certify the quality level of business administration activities, an increasing number of corporations have been obtaining ISO9001 certification (ISO, 2009). ISO9001 contains guidelines for processes of business activities and detailed management activities. Each corporation formulates its own in-house work process and management system, based on these guidelines. Document control is assessed as a part of the management system. For example, regarding documents such as information prepared from the business activities, an enterprise manager must stipulate the preparer of the document, the approver, and assign a management number to stipulate the storage system and time period. As for the concept of the document management system proposed in this paper, the target of knowledge obtained from the project activities in the organizational structure of the aforementioned "Hyper Text type" are documents under the control stipulated in ISO9001 (hereinafter, "Controlled Document").

It is considered that the Controlled Document should enable search to meet needs of people in various positions such as business managers and staff, and yet it should easily be reused. As for the document management system, the management system of a real European-financed Japanese corporate for which the author works is used as an actual case for the development of the argument.

## 3.1 Structure of Document Management

The document management structure covered by the system proposed in this paper is illustrated in Figures 3 and 4. Figure 3 outlines processes from metadata to the Controlled Document. For instance, the author at the R&D division shown in Figure 4 drafts a document in the form of metadata by electronic means such as MS Word. The author, if he or she belongs to an R&D division, assigns a document number of the division as a filename (e.g. TNA2011A001) stipulated by the corporation based on ISO9001, and files the document name as "Document A" (hereinafter, "Doc. A") in the Document Server (Figure 4). In general, each corporation prepares the Controlled Document according to the request of a milestone in work processes (e.g. a meeting for reporting the progress status or settlement of a project). This should be the formal document stipulated in the corporation's ISO9001. It should also be accessible to all pertaining employees, as well as reusable. Figure 4 shows that the Hyper Text type "organization" described in the previous chapter is converted into "document" as an example of a certain corporation.

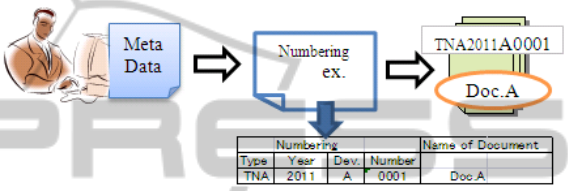


Figure 3: Example: Process of publishing a document.

The document is described as the work process and document issued by respective divisions that utilize the process, and each of them is prepared in the same process as that shown in Figure 3. Here, the relationships between the Hyper Text type corporation responsible for a certain project A, the "Project Team" and the document required in the team is illustrated in Figure 4.

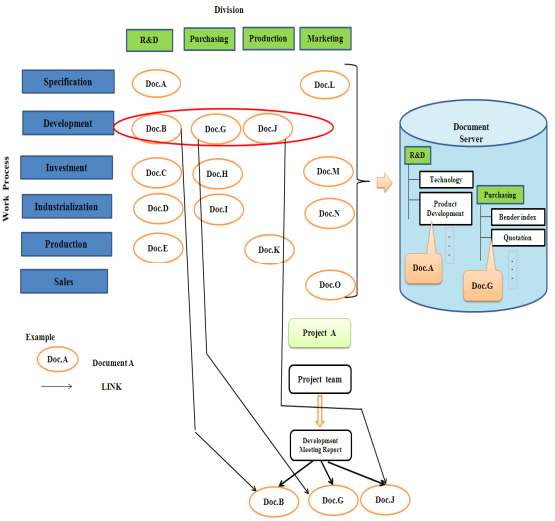


Figure 4: Document Management Structure.

With the aim of completing a certain task called project A, the Project Team consists of one or two representatives (non-full-time in general) dispatched

from R&D, Purchasing, Production and Marketing divisions respectively. This task acts based on the work process stipulated by this corporation. Therefore, the leader of this project must prepare a briefing paper for meetings, during which the progress status is reported based on each milestone of the work process. Consequently, this briefing paper is important knowledge for the corporation, with management information such as specifications and investment necessary for the completion of the project A, technical issues, methods to solve such issues, and the results. The briefing paper can be called a combination of documents prepared by respective team members. However, as the team members who prepare respective documents are dispatched from other divisions, they will assign document numbers stipulated in document management of respective divisions, and file the documents in folders of respective divisions of the document server. As the Hyper Text type organization (in this paper, the "project team") is dissolved at the completion of the task, it is very difficult to retrieve the combination of documents prepared in the organization, even if it is filed in a dedicated folder and is reviewed fully at that time, if a person responsible for the maintenance including revision after the dissolution is unknown, or if leaders of other projects want to refer it, or heads of respective divisions want to refer it.

## 3.2 Outline of Proposed Document Management System

The biggest feature of this system, the ontology that defines the feelings of the search, by matching as a set of documents defined in the domain is to increase the efficiency of the search. As described above, the basic model for this system is the Japanese company which the authors belong to, so documents handled are written in the Japanese language. Also, the needs described above were confirmed by questionnaires from the company's employees (100 people) at various levels. It was confirmed that those needs can be categorized into the following three broad groups.

a. The document number register is linked to each document with a number assigned thereby.
b. Documents created by a project team can be searched in a set.
c. Documents created by a project team and other documents separately created can all be searched by natural language.

For group an above, the matter can be solved by relating documents to the document number register in simple 1:1 links, so this paper's research covers groups b and c, as discussed below. Its system configuration is shown in Figure 5. "GUI Search and Answer" are items to select when a searcher searches for a document. For a real search engine, it builds "Search Engine by Ontology" for adaptation. The reason to use ontology in the search engine is considered to be that for the purpose of obtaining their respective ISO9001 certifications, the business organization discussed in the present paper to be linked in the search engine and the document management system are classified and formulated by a proper tree structure, and the action of document search itself is what should be clarified by ontology.

"Search Engine by Ontology" clarifies the searcher's search goals, and according to those goals, searches for needed documents from the "Document Servers" which stored the documents, thereby replying to the searcher. Figure 6 shows the Class structure outline of "Search Engine by Ontology".

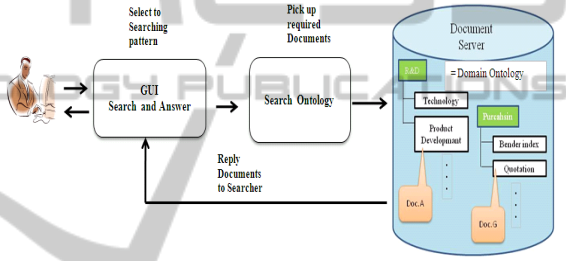


Figure 5: Outline of proposed Document Management System.

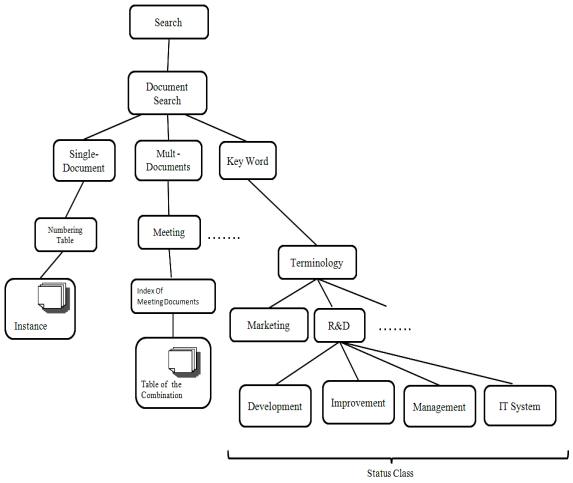


Figure 6: Outline of Class structure outline of "Search Engine by Ontology.

"Document Search" is under the highest conceptual class is "Search". The conceptual classes directly under this were obtained from results of the questionnaire mentioned above, so they are

comprised as Upper and Lower concept. “Single Document” does a search using the registration number register which has 1:1 links with documents. “Multi Documents” is comprised of a group of multiple independent documents. For example, specific documents are needed in regular meetings concerning decision making during a product’s development, so these define the concept of “Meeting”, and the index of documents used in each meeting is defined in a sub-class. As an instance, it has a “Table of combination” which specifically describes that index. That is linked to each document stored in a “Document Server” described below, so they are extracted and provided to the searcher. “Key Word” provides to the searcher abstract search items which can be specified by the company’s departments. “Key Word” also provides the “Status Class” which supports the intentions of the searcher when narrowing down the search results.

The technology of the key word search is now on consideration. However, the planned algorithm is shown in below.

**Planned Algorithm**

$$S_G=\{Concept_1,Concept_2,\cdots, Concept_h\}$$

$S_G$ is the set of concept in the domain Ontology G. "Concept $_i$ "is the concept of the domain Ontology.

$$T_G=\{t_1,t_2,t_3\cdots t_n\}$$

"$T_G$ "is the set of terminology which are used in the domain Ontology G and "$t_i$" is the term.

$$\mathbf{P}=\begin{bmatrix} p_{11} & p_{12} & \cdots & p_{1h} \\ p_{21} & p_{22} & \cdots & p_{2h} \\ \vdots & \vdots & \ddots & \vdots \\ p_{n1} & p_{n2} & \cdots & p_{nh} \end{bmatrix}$$

P expresses the matrix of relation between the concept and the terminology.

P $_{ij}$=”1” If the “t $_i$” means “Concept $_j$”.
= “0” the other.

Calculate “word vector” d $_k$ by counting the frequency d $_{ki}$ that the term t $_i$ appears in the document k which should be searched.

$$d_k={}^t(d_{k1},d_{k2},\cdots,d_{kn})$$

Define the document ontology vector D $_k$ by matrix M which transfers from “word area” to “concept area”.

a (i) $={}^t C^{i\ t} P\ d_k$ a (i) is the “Spreading Activation”.

In case of implementation of the activation to $\lambda$ is shown in below,

$$M=(I+{}^tC+{}^tC^2+\cdots+{}^tC^{\lambda})\ {}^tP$$

“I” is a unit matrix.

$D_k = M\ d_k$

Then, “$\lambda$” should be decided by the depth of the layer of the domain ontology. When “Search Ontology” is given as vector Q, the similarity “Sim (Q, k) “is calculated the same with the “word vector” d $_k$.

$$\mathrm{Sim}(\mathbf{Q}.k)=\cos\theta=\frac{\mathbf{Q}\cdot\mathbf{D}_k}{\|\mathbf{Q}\|\,\|\mathbf{D}_k\|}$$

“Q” is calculated by the same process with the document ontology vector.



## 4 CONCLUSIONS AND FUTURE WORK

The present paper’s proposed document management system is still under construction, but it is considered to have the following advantages.

* As the search engine expressed clearly by “Search Ontology” is used, there is no need to reconstruct many documents stored in the document server.
* Even if the maintenance of search items is required, only the classes constructed by the part-of are modified, so the modification work is easy.
* After the completion of the task, documents used in the project are reusable in the latest edition, even if they are revised.
* Clients in divisions not involved in the project can also refer to documents in respective projects or past cases.

With the globalization of management and speeding up of product development, Japanese corporations have recently shifted their organizations from conventional bureaucracies to a flat Hyper Text type, or are working to fuse these two types. Therefore, the document management system aimed at in the present paper is considered useful not only in Japanese corporations, but also in the world’s business administration in the future. From this time forward, we will continue to study the following themes.

* Clarify the document search, and construct the sub-classes of “Search Ontology”.

For the clarification of document search, conduct a questionnaire at the company for which the author works, analyze the result, and decide on the sub-classes of the search ontology.

* Break documents into morphemes in the Document Server, and extract semantic key words. And start to experiment by planned algorithm with the above themes, using around 1000 documents, verify the effectiveness of the document management system proposed in the present paper.

## REFERENCES

OECD, THE KNOWLEDGE-BASED ECONOMY, Knowledge Based Economy, GENERAL DISTRIBUTION OECD/GD, Vol. 96, No. 102, 1996.

Ikujiro Nonaka and Hirotaka Takeuchi, The Knowledge-Creating Company. How Japanese Companies Create the Dynamics of Innovation, *Oxford University Press*, New York, 1995.

Enkel, E., Back, A. and Krogh, G. von, The concept of knowledge networks for growth, in Back, A., Enkel, E., Krogh, G. von (eds.), *Knowledge Networks for Business Growth*, Springer 2007.

Duncan, R. and Weiss, Organizational Leaning: Implications for Organizational Design, *Research in Organizational Behavior*, Vol.1, pp. 75-13 1979.

Élise Lavoué, E. A Knowledge Management System and Social Networking Service to connect Communities of Practice., IC3K 2010, CCIS 128, Fred A. et al. (eds.), Springer, Heidelberg, p. 310-322, 2011.

Ackoff, R. L, From data to wisdom, J. Appl. Sys. Anal., vol. 16, pp. 3-9, 1989.

Wenger, E., McDemott, R. and Snyger, W., Cultivation community of Practice, *Harvard Business School Press*, 2002.

V. Richard Benjamins, Dieter Fensel and Asuncion Gomez Perez, Knowledge Management through Ontologies., *In proceedings of the Second International Conference on Practical, Aspects of Knowledge Management* (PAKM), Also in proceedings of Pacific Asia Conference on ExpertSystems (PACES'99), LA, CA, 1999.