Designing Organizational Memory for Knowledge Management Support in Collaborative Learning

Kam Hou VAT
Faculty of Science & Technology, University of Macau, Macau
fstkhv@umac.mo

ABSTRACT

This paper investigates the design of organizational memory (OM) which is targeted for knowledge management (KM) support tailored for collaboration among academic staff and students in a university environment. Specifically, we describe our KM initiatives to support organizational learning in terms of the knowledge processes evolving over selected knowledge domains for training and research purpose. The paper also depicts our ideas on knowledge items regarding their meta-modeling, indexing, and ontological aspects. The overall design of our OM is then discussed in terms of its context for knowledge work. The paper concludes by re-iterating the challenges in knowledge sharing and depositing into the OM for its continuous growth and utilization.

1 INTRODUCTION

In the emerging knowledge economy, the recognition that knowledge is one of the organization's key assets, has fueled interest in researching into the various activities of knowledge management (KM): identification, collection, adaptation, preservation, application and sharing of the organization's knowledge [11, 27]. A university can be considered as a knowledge organization whose valuable assets come from her teams of knowledge workers, who have a strong formal education, have learned how to learn, and have a habit of continuing to learn throughout their lifetime. Yet, intellectual assets belong inherently to people, and are the organization's assets only through their application and reuse [6]. These are good reasons to capturing the intellectual knowledge of people, however implicit it may be, and making it explicit within an organization whose competitive advantage comes from having and effectively using knowledge. We believe that an organizational memory (OM) is a facility that could extend and amplify this knowledge asset by capturing, organizing, disseminating and reusing the knowledge created by our knowledge workers. It can be shared among individuals working alone, by teams needing a project memory, and by the organization as a whole for long-term and short-term goals. This paper investigates the design of such an OM together with the KM support necessitated by organizational learning (collaboration) [2, 12, 17] among knowledge workers in an electronic university environment we call VU, representing our Virtual University model.

2 THE CURRENT STATUS OF KNOWLEDGE MANAGEMENT

According to O'Leary [19, 20], KM entails managing knowledge resources in order to facilitate access and reuse of knowledge, typically by using advanced information technolo-gies (IT). It attempts to address such issues as: capitalizing on individual know-how in a collective knowledge; improving newcomer learning and integration; disseminating best practices; improving organizational work processes and productivity [11]. Essentially, knowledge is often classified according to some pre-specified (but evolving) categories into structured and semi-structured data and knowledge bases. Typically, KM systems represent knowledge in both human-readable and machine-readable forms. The former is accessed using browsers, whereas the latter is often designed as an expert system's knowledge base to support decision-making. Meanwhile, ontology specifications are generally endemic to KM systems because they refer to taxonomies of the tasks that define the knowledge for the systems [5, 25]. Specifically, ontologies define the shared vocabulary used in the KM system to facilitate communication, search, storage, and representation of knowledge. According to Conklin [6], there are generally two types of organizational knowledge: formal and informal. Formal knowledge refers to the stuff of books, manuals, documents, and training courses. It is the primary work product of the knowledge worker, captured easily by the organization. And informal knowledge is the knowledge created and used in the process of creating the formal results. It includes ideas, facts, assumptions, meanings, questions, decisions, guesses, stories, and points of view. It is as important in the work of the knowledge worker as formal knowledge is, but is more ephemeral and transitory. Thus, it is hard to capture and to keep, especially in the artifact-oriented culture of our work environment, where we tend to value results – the output of the work process – far above the process itself. As knowledge employees turn over in today's job market, organizations are likely to lose access to large quantities of critical knowledge. The question is how we can create an OM-based system that will capture organization-wide knowledge (formal and informal) and make it widely available to all its members.

3 THE VISION OF ORGANIZATIONAL MEMROY

We envision that an OM's major function is to enhance the organization's competitiveness by improving the way it manages its knowledge. It is the core of a learning organization, supporting sharing and reuse of individual and organizational knowledge and lessons learned. It is supported by intelligent KM services actively providing any user working on a knowledge-intensive task with the information required for fulfilling the task. Such information is largely based on the organization's formal knowledge, captured through explication of informal knowledge within the organization, and is supported by such IT tools as expert systems, issue-based information systems (IBIS), best-practice databases, and lessons-learned archives. This perspective of the OM emphasizing the support of the human user

by providing, maintaining, and distributing relevant information and knowledge, is not centered around the idea of a passive information system or an autonomous problem-solver, but an intelligent assistant to the user [1, 3, 22]. Actually, this intelligent assistant view of OM corresponds well with the shift of focus in AI. While an important AI goal has been to build knowledge-based systems that solve challenging problems on their own, an intelligent assistant system cooperates with a human user in contributing to a possible solution by performing what might be done, but letting the user decide, thus distinguishing workload versus decision competence. This combination of the assistant system and the user should improve both problem-solving capabilities and user acceptance. According to Brooks [4], this vision of OM is often characterized as IA, denoting intelligence amplification, which carries the connotation that a machine and a mind is superior to a mind-imitating machine (conventional AI approach) working by itself in problem-solving.

4 THE OM SCENARIO FOR KM SUPPORT

One of our VU's learning experiences is to enable knowledge development and transfer among teachers and students in an interactive and collaborative atmosphere. Students actively participate in generating, accessing, and organizing the required information. They construct knowledge by formulating their ideas into words and then develop these ideas as they react to other students' or teachers' responses to their formulations. Knowledge construction can then be considered as the process of progressive problem solving, which encourages students to be innovative, create intellectual property, and develop and acquire expertise. To achieve these knowledge tasks, our academic staffs need considerable skill and knowledge to deal with the acquisition, creation, packaging, and application of emergent knowledge. An OM could help users perform these knowledge tasks through knowledge sharing across academic domains. It is about leveraging the expertise of people and making the most effective use of the intellectual capital of an organization [24]. Typically, when a knowledge worker (professor or student) recognizes an information need within the actual flow of work, a query to the OM must be derived. This query is generated as specifically as possible according to the actual work context. On the other hand, the OM can also store new information created within a given working scenario in a contextually enriched form such that subsequent retrieval processes might compare the query context with the creation context for relevance estimation. Thereby, knowledge sharing among organization members must be supported by the ability to search for information based on different contextual criteria, to find linkages between different types of information, and to relate information with people. These represent some of the key aspects of KM support to be addressed when building an OM system to realize context-sensitive knowledge supply.

5 THE OM REQUIREMENTS FOR ORGANIZATIONAL LEARNING

In the literature on knowledge management [18, 27, 28, 29], four basic knowledge processes are identified, with OM concerns: a) *Developing knowledge (development).* Organizations survive by the continuous development of new knowledge based on creative ideas, the analysis of failures, daily experiences and work in research and development (R&D). OM can support these processes by tracking failures and successes; b) *Securing knowledge (storage).* Individual knowledge must be made accessible to others in the organization at the right time

and place. Knowledge stored in the OM is meant to be persistent and if indexed properly, can be retrieved easily; c) *Distributing knowledge (distribution).* Knowledge must be actively distributed to those who need it, with the shortest turn-around time to enhance organizational competitiveness. OM needs a facility to determine who should be informed about a particular piece of new knowledge; d) *Combining knowledge (combination).* An organization can perform at its best if all available knowledge can be combined in its new products and services. OM may facilitate this combination by making it easier to access knowledge developed in different parts of the organization. To understand how these processes are inter-related, we consider a scenario of organizational learning among knowledge workers. They often test their learning by applying the new knowledge themselves. Then they will communicate the results to their fellow workers. If the lesson learned is truly effective, they will put it down in their manuals that become part of the knowledge records of the organization.

When implementing an OM for organizational learning, we consider the following modes of learning: 1) individual, 2) group, and 3) repository. Individual learning is characterized by knowledge being developed, and possibly the result of combining an insight with know-how from other sources in the organization, it is often not distributed and is not secured for reuse. Group learning is centered about the concept of communication in two possible modes: supply-driven, or demand-driven. The former is characterized by an individual who has found a way to improve the work process and communicates this to one's co-workers. The latter refers to a worker who has recognized a problem in the current process and asks fellow workers whether they have a solution for this problem. In each case, knowledge is developed, distributed, and possibly combined with knowledge from other parts of the organization, but it is seldom secured. In repository learning, the communication element is replaced by collection, storage and retrieval of knowledge items. Namely, it is typified by storing lessons learned in some information repository so that they can be retrieved and used when needed. Overall, in repository learning, knowledge is developed, secured, distributed, and is possibly the result of knowledge combination.

It is convinced that the requirements of an OM implementation should be formulated in terms of the above KM processes. Namely, an OM should facilitate individual workers to access the knowledge required by combination, to submit a lesson learned, and to decide which of the co-workers would be interested in a lesson learned. Also, there should be criteria to determine if something is a lesson learned, how it should be formulated and where it should be stored, and how to distribute some newly asserted knowledge piece to the workers in need. The perceived technical issues, nevertheless, could include the following: How are we to organize and index the OM to enhance its diffusion? How to retrieve relevant elements of the OM to answer a user's request or proactively push relevant elements towards users? How to adapt the answer to users, in particular to their tasks, according to the knowledge contexts? These problems are largely related to information retrieval, and they are bound to the OM framework for knowledge distribution, whose goal is to improve organizational learning, with the aid of some organizational KM support.

6 DESCRIBING OM'S KNOWLEDGE ITEMS

In developing the mechanism to secure organizational knowledge, our experimental OM has chosen the CommonKADS

organization model proposed by de Hoog et al [8, 9, 26], where knowledge items are modeled as objects with a number of attributes commonly classified into three groups as shown in the following table.

General	Name:	
	Role description:	The Role the knowledge is associated with
	Activity:	The related organizational task(s)
	Domain(s):	Reference to organizational areas/objects/processes
Content	Generic task type:	From the CommonKADS library tree
	Nature:	Heuristic, formal, uncertain …
	Products/services:	Marketable products of the organization
	Functions:	Organizational functions involved
Availability	Time:	When available
	Location:	Where available
	Form:	Paper, electronic, mind, collective

Table 1: Knowledge items as used in the CommonKADS organization model

· *Activities*. This attribute refers to the organizational activities to which the knowledge item is related. Every organization should have an explicit model of the activities that are performed as part of the work processes. The names of these activities can then be used as values on this attribute.

· *Domains*. This attribute is related to the subject of the knowledge item. To use this attribute, organizations should have an inventory of relevant knowledge domains. This inventory is a meta-description of the types of knowledge that exist in the organization. And it is specifically developed according to the contexts of knowledge work in the individual organization.

· *Form*. This attribute concerns the physical representation of a particular piece of knowledge. De Hoog et al. identify four possible values for this attribute: paper, electronic, mind and collective, where the last one is actually referring to the availability issue instead of the physical form. Overall, the number of possibilities should be sufficient to allow an organization to specify the different forms in which knowledge is available physically.

· *Type*. This attribute specifies the type of document relating the knowledge item. Possible values include concepts such as protocol, procedure, guideline, handbook, manual, best/worst practice, progress report, white paper, evaluation report, and many others. Such values are assumed to be reusable across a wide range of organizations, even though individual organizationsmay choose to use only a limited subset.

· *Products/Services*. These attributes relate the knowledge items to the products and services of an organization. These attributes enable the OM to improve communication with the knowledge workers and outside clients. The possible values are often organization-specific, and should be obtained with no particular difficulties.

· *Time and location*. These attributes are relevant for knowledge items, which have "mind" as value on the form attribute. Since certain knowledge is only available in a personal form, the OM should make it easy to find out how and where this particular person can be contacted. Actually, the OM should contain knowledge profiles of all the workers in the organization. These profiles should be formulated using the same attributes and attribute values as used for knowledge items. More specifically, such profiles, usually under the control of knowledge workers, should carry knowledge items that are about the activities, domains, and products/services, which are directly related to their current knowledge work.

7 INDEXING OM'S KNOWLEDGE ITEMS

In implementing the indexing mechanism for knowledge items in our OM, we have considered the installation of three basic types of navigation mechanisms for searching flexibility. They include hierarchical search, attribute search and content search. The first method organizes knowledge items in a fixed hierarchical structure. An example of this search is illustrated by following hyperlinks on the Web documents. The second method searches the OM by specifying values for attributes, and knowledge items are returned which have the specified values on the attributes. Database engines typically use this type of searching. The third method entails users entering arbitrary search terms related to the topic of interest. The search simply returns all the knowledge items in which the terms occur. An example is the crawler of most search engines on the World Wide Web. Basically, content search could be considered as the most flexible method; however, its ability to find the appropriate documents depends heavily on the capacity of the user to formulate suitable search terms. And it is confined to textual knowledge items, the amount of structure in the OM, and the number of possibly relevant knowledge items. And attribute search is the second most flexible method because indexing through hierarchical structure can be considered as a compiled form of attribute indexing where the order in which the attributes are specified is preset. But it still requires a pre-defined set of attributes.

8 CONCEIVING OM'S ONTOLOGIES

Two types of ontologies that have been useful to our OM development are domain ontologies and enterprise ontologies for describing an organizational model. Examples of enterprise ontologies include the Enterprise Ontology [15] proposed by the University of Edinburgh's Artificial Intelligence Applications Institute (AIAI), and the TOVE (Toronto Virtual Enterprise) ontologies [16], proposed by the University of Toronto. The former has five sections: activity, organization, strategy, time and marketing. The latter comprises five core ontologies: activity, organization, product, resource, and service. These ontologies characterize knowledge items on a global level for organizational modeling. And they have been used to standardize the allowed values for some of the attributes of knowledge items in our OM. As for the domain ontologies, since they could be largely different for different knowledge domains, they have to be derived separately. Our job is to identify the vocabulary and thus the underlying conceptualizations of the kinds of objects and relations that can exist in the domain. In most cases, the emerging ontologies [10] have the form of networks of categories of concepts, with an explicit representation of hierarchy among them. In developing our domain ontology, we have concentrated on representing the vocabulary of the problem domain, different kinds of relationships between its concepts, concept properties, constraints, and rules for extending the vocabulary. To help modeling the specific domain, we have also borrowed the following concepts from object-oriented analysis and design [5]: There are *objects* in the world. Objects have *properties* or *attributes* that can take *values*. Objects can exist in various *relations* with one another. Properties and relations can change over *time*. There are *events* that can occur at different *time instants*. There are *processes* in which objects participate and that occur over time. The world and its objects can be in different *states*. Events can cause other events or states as *effects*. And objects can have *parts*.

9 CHARACTERIZING OM-BASED KNOWLEDGE WORK

According to Spek and Spijkervet [23], organizational knowledge can be characterized by knowing which information is needed (know what); knowing how information must be processed (know how); knowing why information is needed (know why); knowing where information can be found to achieve a specific result (know where); and knowing when which information is needed (know when). Individual knowledge workers construct and re-construct organizational knowledge through sharing with their colleagues. These include [11]: human knowledge sources, whose knowledge must be made explicit so that others can access through the OM; knowledge engineers, who acquire and model knowledge; knowledge watchers, who gather, filter, analyze, and distribute knowledge elements from the external world; OM developers, who concretely build, organize, annotate, maintain, and evolve the OM; a team of validating experts, who validate the knowledge elements before their insertion in the OM; OM users, who can easily access and reuse memory elements; and OM managers, who supervise the OM project. Meanwhile, the OM context for our VU could further be refined for different faculties, departments, programs, courses, groups, or communities, gathered by a common interest of organizational learning.

10 CONCLUSION

This paper sketches our preliminary effort to design an OM to secure organizational knowledge that is shared among organizational members. Although organizational knowledge is created via individual knowledge, complete organizational knowledge is achieved only when individuals keep modifying their knowledge through interactions with other members [2, 17]. This is the process through which organizations continually refresh and update their intellectual capital. Organization members act as learning agents, responding to changes in the internal and external environments of the organization. More importantly, the agents' discoveries, inventions, and evaluations are shared through the organizational shared memory. We are convinced that implementing the VU's OM is an important effort to realize our university's shared memory. And the recent popularity of the Web has provided a tremendous opportunity to expedite the dispersement of various creation/diffusion infrastructures [7, 13, 14, 21], particularly those of developing global collaborative KM platforms. It is believed that a well-devised OM with user-friendly KM services enhances the probability of seamless knowledge acquisition, sharing, and integration among organization members. The challenge that organizations now face is how to design KM services to turn the scattered, diverse knowledge of their knowledge workers into well-structured knowledge assets ready for deposit and reuse in their OMs.

REFERENCES

[1] Abecker, A., Bernardi, A., Hinkelmann, K., et al., "Toward a Technology for Organizational Memories," IEEE Intelligent Systems, Vol. 13, No. 3, May/June 1998, pp. 40-48.

[2] Argyris, C., and Schon, D.A., "Organizational Learning: A Theory of Action Perspective," Addison Wesley, Reading, MA, USA, 1978.

[3] Baek, S., Liebowitz, J., et al., "Intelligent Agents for Knowledge Management – Toward Intelligent Web-Based Collaboration within Virtual Teams," In J. Liebowitz, (ed.), Knowledge Management Handbook, Springer-Verlag, 1999.

[4] Brooks, F.P., "The Computer Scientist as Toolsmith II," Comm. ACM, Vol. 39, No. 3, Mar. 1996, pp. 61-68.

[5] Chandrasekaran, B., Josephson, J.R., and Benjamins, V.R., "What Are Ontologies, and Why Do We Need Them?" IEEE Intelligent Systems, Vol. 14, No. 1, Jan/Feb 1999, pp. 20-26.

[6] Conklin, E.J., "Designing Organizational Memory: Preserving Intellectual Assets in a Knowledge Economy," white paper, Group Decision Support Systems, Washington, D.C., 1996; http://www.gdss.com/DOM.htm.

[7] Corby, O., and Dieng, R., "The WebCokace Knowledge Server," IEEE Internet Computing, Vol. 3, No. 6, Nov./Dec. 1999, pp. 38-43.

[8] De Hoog, R., et al., "Organization Model: Model Definition Document," Technical Report. Univ. Amsterdam and Cap Programmator. Deliverable DM6.2c of ESPRIT Project P5248 (KADS-II), 1994.

[9] De Hoog, R., et al., "The CommonKADS Organization Model: Content, Usage, and Computer Support," Expert Systems with Applications, Vol. 11, No. 1, July 1996, pp. 247-260.

[10] Devedzic, V., "Ontologies: Borrowing From Software Patterns," ACM SIGART Intelligence, Vol. 10, No. 3, Fall 1999, pp. 14-24.

[11] Dieng, R., "Knowledge Management and the Internet," IEEE Intelligent Systems, Vol. 15, No. 3, May/June 2000, pp. 14-17.

[12] Dodgson, M., "Organizational Learning: A Review of Some Literature," Organization Studies, 1993, Vol. 14, No. 3, pp. 375-394.

[13] Eriksson, H., "Expert Systems as Knowledge Servers," IEEE Expert, Vol. 11, No. 3, June 1996, pp. 14-19.

[14] Euzenat, J., "Corporate Memory through Cooperative Creation of Knowledge Bases and Hyper-documents," In Proc. 10th Banff Workshop on Knowledge Acquisition for Knowledge-Based Systems (KAW'96), B. Gaines and M. Musen, eds., SRDG Publications, Calgary, Canada, 1996.

[15] http://www.aiai.ed.ac.uk/project/enterprise/enterprise/ontology.html

[16] http://www.ie.utoronto.ca/EIL/tove/toveont.html

[17] Kim, D.H., "The Link between Individual and Organizational Learning," Sloan Management Review, Fall 1993, pp. 37-50.

[18] Nonaka, I., and Takeuchi, H., "The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation," New York: Oxford Univ. Press.

[19] O'Leary, D.E., "Enterprise Knowledge Management," IEEE Computer, Vol. 31, No. 3, Mar. 1998, pp. 54-61.

[20] O'Leary, D.E., "Using AI in Knowledge Management: Knowledge Bases and Ontologies," IEEE Intelligent Systems, Vol. 13, No. 3, May/June 1998, pp. 34-39.

[21] Shum, S.B., "Negotiating the Construction of Organizational Memories," In U.M. Borghoff, and R. Pareschi (eds.), Information Technology for Knowledge Management, Springer-Verlag 1998, pp.55-78.

[22] Silverman, B.G., Bedewi, N., and Morales, A., "Intelligent Agents in Software Reuse Repositories," ACM CIKM Workshop on Intelligent Information Agents 1995.

[23] Spek, R, and Spijkervet, A.L., "A Methodology for Knowledge Management," Tutorial Notes of The 3rd World Congress on Expert Systems, Seoul, Korea, 1996.

[24] Stewart, T.A., "Intellectual Capital: The New Wealth of Organizations," Doubleday, New York, 1997.

[25] Swartout, W., and Tate, A., "Ontologies," IEEE Intelligent Systems, Vol. 14, No. 1, Jan/Feb 1999, pp. 18-19.

[26] Van der Spek, R., and De Hoog, R., "A Framework for a Knowledge Management Methodology," In: Wiig, K.M. (ed.), Knowledge Management Methods. Arlington, TX, USA: Schema Press, 1995, pp. 379-393.

[27] Van der Spek, R., and Spijkervet, A., "Knowledge Management: Dealing Intelligently with Knowledge," Utrecht, The Netherlands: IBIT series No. 1, Kenniscentrum CIBIT.

[28] Van Heijst, G., Van der Spek, R., and Kruizinga, E., "Organizing Corporate Memories," In Proc. KAW'96, University of Calgary, Knowledge Science Institute., 1996; http://ksi.cpsc.ucalgary.ca/KAW/KAW96/KAW96proc.html.

[29] Wiig, K.M., "Knowledge Management: The Central Management Focus for Intelligent-Acting Organizations," Arlington, TX, USA: Schema Press, 1993.

Related Content

Human Supervision of Automated Systems and the Implications of Double Loop Learning
A.S. White (2013). *International Journal of Information Technologies and Systems Approach (pp. 13-21).*
www.irma-international.org/article/human-supervision-of-automated-systems-and-the-implications-of-double-loop-learning/78904

Research on Power Load Forecasting Using Deep Neural Network and Wavelet Transform
Xiangyu Tan, Gang Ao, Guochao Qian, Fangrong Zhou, Wenyun Liand Chuanbin Liu (2023). *International Journal of Information Technologies and Systems Approach (pp. 1-13).*
www.irma-international.org/article/research-on-power-load-forecasting-using-deep-neural-network-and-wavelet-transform/322411

Elitist-Mutated Multi-Objective Particle Swarm Optimization for Engineering Design
M. Janga Reddyand D. Nagesh Kumar (2015). *Encyclopedia of Information Science and Technology, Third Edition (pp. 3534-3545).*
www.irma-international.org/chapter/elitist-mutated-multi-objective-particle-swarm-optimization-for-engineering-design/112785

The Optimization of Face Detection Technology Based on Neural Network and Deep Learning
Jian Zhao (2023). *International Journal of Information Technologies and Systems Approach (pp. 1-14).*
www.irma-international.org/article/the-optimization-of-face-detection-technology-based-on-neural-network-and-deep-learning/326051

Using Communities of Inquiry Online to Perform Tasks of Higher Order Learning
Ramon Tirado-Morueta, Pablo Maraver-Lópezand Ángel Hernando-Gómez (2018). *Encyclopedia of Information Science and Technology, Fourth Edition (pp. 3976-3987).*
www.irma-international.org/chapter/using-communities-of-inquiry-online-to-perform-tasks-of-higher-order-learning/184105