Understanding Organizational Memory

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Abstract

Many Organizational Memory (OM) models and definitions can be found in the literature. Most models are complex or too general to directly build a computer system to manage them, i.e., to capture significant information, organize it and make it available to people who needs it. This paper presents a review of some OM models as well as some systems intended to manage part of the information stored in it. A few observations about the human memory from a cognitive science point of view are also included, giving design ideas for new OM systems. Finally, a new OM model is presented. This model is based on a previous collaborative application. The model emphasizes information privacy aspects.

1. Introduction

The study reported in this paper concerns the definition of Organizational Memory (OM). Since this is a term used for two decades (Hedberg [10] introduced it in 1981) there are many meanings for it. A new one is indeed proposed in this study. The understanding of what is OM helps to formulate proposals on systems which may be useful for the organization or its managers.

The *memory* concept for a machine or an organization is a powerful metaphor. Everyone knows about human memory basic functions and thus it is easy to guess that an artificial entity should have *remembering* abilities. However, artificial memories in detail may not follow brain models closely: there are no well-known studies of OM using cybernetics or biological models. Instead, OM models typically concentrate on the types of information or knowledge to be managed and the processes of capturing, retaining, accessing and using such knowledge in the organization.

Information makes currently a high percentage of the cost of a product as compared to "materials", as many economic studies show. Also, the knowledge of the employees is one of the most important assets of a company or institution. These facts help to justify an OM as a resource to protect knowledge, as presented by several authors (see, e.g., [7]).

A simple first idea of an OM is to think of it as an aggregation of the human memories of all employees of the organization. Clearly this model lacks the information which belongs to the organization itself or the one which employees are not eager to keep in their private memories but it is important to the organization. Even more, the persistence of this memory may be dubious, especially if employees leave the organization. Thus, one needs memory extending or complementing employees' memories.

Pautzke (as cited by Lehner and Maier [12]) presents a layered model of knowledge accessible or not within the organization. Figure 1 presents this model. The first two layers (from inside) include information already shared by all employees or information which is accessible for the organization. The OM role, then, in this context is to enlarge these two layers, increasing the shared or accessible knowledge for the members of the organization.

Another observation to be made about Pautzke's model concerns the third layer: knowledge which belongs to individuals but is not accessible to the organization. Part of it one would like to make it available to the organization. Lehner and Maier suggest three ways to do this:

- Nothing special: employees *use* their private knowledge in whatever they do for the organization. The problem is when employees leave the organization.
- Distribute the knowledge of individuals among several employees through discussions. This assumes employees are willing to share their knowledge.
- Institutionalize knowledge: employees *include* in the results of their work their knowledge. This strategy is very limited as some knowledge cannot be formalized.

The second strategy is very promising, especially if discussions are also used for other purposes. For instance, Romero et al. [19] have proposed to collect asynchronous discussions to prepare meetings as the base for the building of an OM. An important problem concerning this strategy is the privacy implications, as will be developed in Section 4.

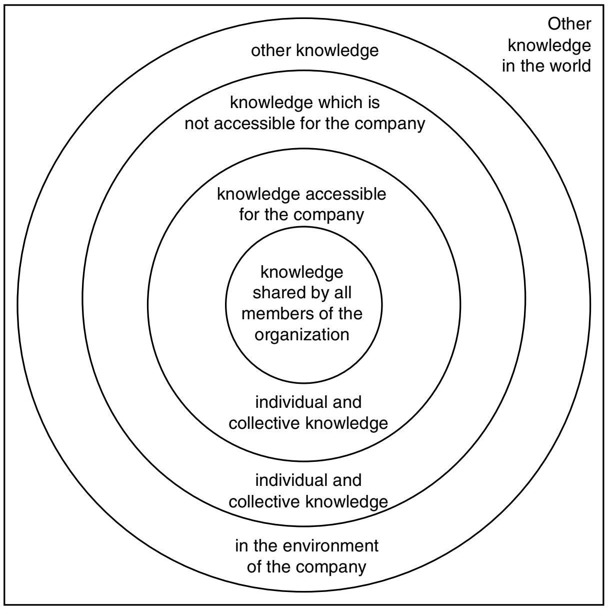

Figure 1. Pautzke' organizational knowledge model

The rest of the paper is organized as follows. Section 2 presents approaches to OM from a management point of view. Section 3 presents some OM definitions influenced by technology. Section 4 examines human memory from a psychological point of view and studies how these characteristics can influence the design of an OM. Section 5 proposes a new OM model and Section 6 contains the conclusions of this study.

2. Organizational memory models

Walsh and Ungson [22] call *bins* to the OM storage structures. These authors consider what is remembered (OM contents) as different to how it is remembered (bins), emphasizing the importance of the contents. According to Walsh and Ungson, the bins or storage components which make up the structure of the OM are: individuals (the memories of the employees about activities and events occurring in the workplace), organizational culture (the learning about the organizational issues and how this experience is passed on), transformation mechanisms (such as routines and procedures), organizational structure (roles and rules), ecology (physical composition and arrangement of the workspace) and sources outside the organization (records obtained from the competition, Government, marketing agencies, public media, etc.). Stein and Zwass [21] add "information systems" to the bins defined by Walsh and Ungson. Figure 2 shows the OM structure as proposed by Walsh and Ungson.

As shown in Figure 2, the OM information is considered in the context of supporting organizational decision making activities. The purpose of the OM is seen as the relation of past and present situations to the current decision making process.

Watson [23] defines "organizational memory" as a technological entity. The required tasks in an OM are very similar to those of data management. Watson believes there are two key questions: Where and how is data stored? How can the data be accessed? Figure 3 shows the most relevant components of his model.

Watson assumes the organization somehow needs to store information in order to make decisions and cope with daily operations. Like Walsh and Ugson, Walsh believes the OM can be fed with outside information.

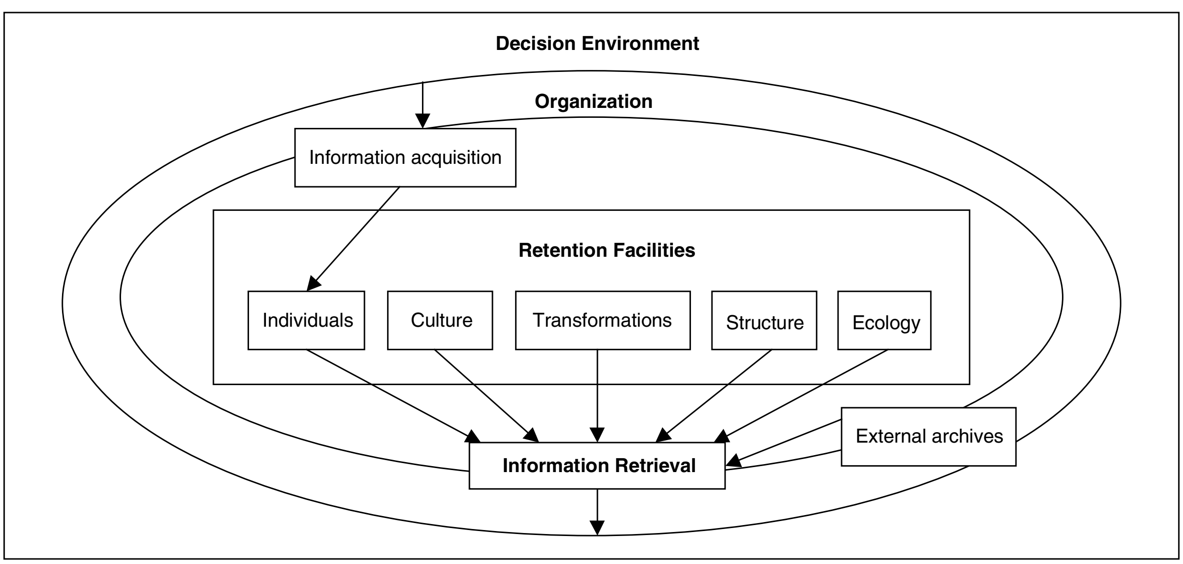

Figure 2. Organizational memory model according to Walsh and Ungson

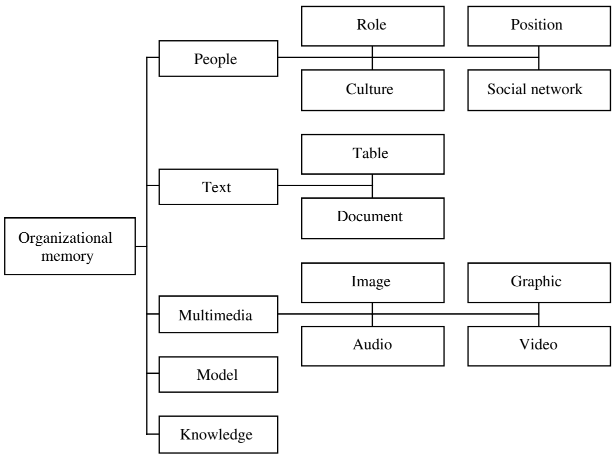

Figure 3. Watson's organizational memory model

To distinguish the data, information and knowledge terms, Watson suggests define data as facts which have not analyzed nor summarized (raw data). Information is data processed into a meaningful form, although "meaningful" depends on the context; e.g., one person's information can be another's data. Finally, knowledge is explained as the ability to use information, i.e., know what information is required and which is the meaning of such information. Figure 4 shows relationships among these terms.

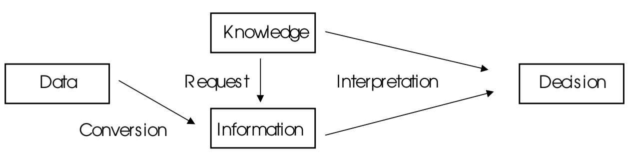

Figure 4. Relationships among data, information and knowledge, according to Watson

Conklin [7] states that the OM allows to capture, organize, disseminate and re-use knowledge created by the employees of an organization. This is useful, according to the author, because organizations "forget" what they have done in the past, as well as the corresponding rationale. He distinguishes two types of knowledge: formal and informal. Formal knowledge is included in books, manuals, documents and training courses. This knowledge is used by the knowledge worker to create spreadsheets, reports, white papers, designs, memos, etc. Organizations easily and routinely capture this knowledge. The other type of knowledge is involved in the formal results creation *process*. This includes ideas, facts, assumptions, meanings, questions, decisions, guesses, stories, and points of view. This type of knowledge, called "informal knowledge", is difficult to capture and maintain, and is generated both by individuals and interacting groups. Most informal knowledge never becomes formal knowledge. Nevertheless, some organizations have lately begun to use groupware systems to support work done by some groups. Since much of the informal communication among group members is done through the groupware system, this software has potential to capture the organizational informal knowledge. Specifically, the groupware systems may build informal knowledge repositories. Conklin concludes OM creation and usage must not be considered as an isolated activity. If the goal is to preserve the value of informal knowledge then the daily practices of the work groups must be observed and changed if needed.

Acoording to Wegner [24], group memory refers to the ability to store the generated knowledge by a group during its working period. Wegner introduces the "transactive memory system" (TSM) term. A TSM is composed of three elements: individual memory (people's knowledge and the knowledge on the stored knowledge, also called meta-memory), external memory (information in CDs, books, computers, etc.), and transactive memory (information is processed in transactions, in which there are several persons involved in the processes of coding, storage and recall information). A TSM is built from individual memory plus communication among group members.

Schwartz et al. [20] suggest three aspects to be included in the management of Internet-based knowledge: acquire (how we collect knowledge from members of the organization or other resources, and store them in an OM), organize (structuring, indexing and formatting the acquired knowledge so we can find it when we look for it), and distribute (get the relevant knowledge to the person who needs it at the right time).

Abecker [1] suggests an OM must capture, store, disseminate and facilitate the use of context dependent knowledge. This knowledge is present in organizations in different ways:

- Organizational knowledge of formal nature (like business rules, design guidelines, etc.). This is difficult to acquire and remember by employees; it constantly changes.
- Individual or group experiences (tacit knowledge which is not sufficiently documented and shared with other employees). In order to share knowledge, it is possible to have lessons learned archives, best practice databases, etc.
- Knowledge contained in (multi- and hypermedia) documents and in databases (e.g., technical documentation, hypertext manuals, product data, video tapes, images, office letters, old workflow instances etc., which is often hard to find, exploit, and utilize).

3. Knowledge Management Systems

Various terms are used in the literature to refer to systems intended for OM Management. Some of them are: OMIS (Organizational Memory Information Systems), CSOM (Computer-Supported Organizational Memory), OMS (Organizational Memory Systems) and KMS (Knowledge Management Systems).

Lehner and Maier give the following definition: A knowledge management system (KMS) is a dynamic system which provides functions to support the identification, acquisition, retention, maintenance, search and retrieval, distribution, selling and logistics of knowledge, which is seen as information plus context, the aim of which is to support organizational learning and organizational effectiveness [12]. Some examples of proposed KMS are described below.

Answer Garden.

Answer Garden [2] was designed as a way to support information search in an organizational context. It provides a database with answers to frequently asked questions. It should support situations in which questions are asked: many of them are repeated but some are new. This kind of situations arises in customer technical support services, telephone "hot lines" for product lines, customer service personnel, etc. Answer Garden provides a tree structure to organize questions and allow searches. In an initial screen, users are shown several subjects on which it is possible to request further information. When the user clicks on one of the displayed subjects, he is taken to a second node containing a set of choice questions concerning the subject. The person eventually finds the required answer by navigating this questions tree. Each node has several options, e.g., one of them lets see the whole answers tree. If a user does not find an appropriate answer, he may add a new question which will be answered by an expert. The expert is also responsible for maintaining the tree structure.

TeamBox.

TeamBox [14] developers state knowledge can be stored in five data types: meta-data, structured data, semi-structured data, unstructured data, and temporal data. The meta-data associates raw data with the context and the process by which it was created. For example, an email message is associated to a project and to a work group and the message was sent to announce the results of a poll. This data is essential when various applications are used within the same collaboration context. Structured data consists of files and records generated by the applications. Semi-structured data is generated during collaborative activities. Unstructured data refers to audio and video, which may be used to support a collaborative activity. Temporal data is information which may vary with time, e.g., when revising documents and making new versions. These variations occur over structured, semi-structured and unstructured data.

TeamBox implements the notion of collaborative transactions. A collaborative transaction is a series of formal activities (which may be stored in a computer) satisfying a team goal. The "transaction" term is used as a metaphor to represent context, i.e., it is the "glue" associating various inter-related activities. Examples of collaborative transactions are: vote, mail, brainstorm, whiteboard, etc. Certain activities must be done in each transaction. For example, in the Brainstorm system, these activities must be: to propose topics, add ideas, update ideas, etc. In TeamBox, each collaborative activity is seen as a transaction, where it is possible to represent knowledge using the five data types mentioned above. The contents (data) of an activity is created, stored and edited using any single-user application or groupware system. TeamBox captures meta-data information and provides a blackbox which allows users of various collaborative or individual applications to interact. Coordination of collaborative transactions is done in any-time any-place environments. TeamBox also serves as a repository for group memory.

QuestMap.

QuestMap [7] is an OMS intended to capture informal knowledge. Conversations are represented in a graphical map format. These QuestMap conversations are structured according to the IBIS rhetorical model [8]. The IBIS elements (issues, positions and arguments) have corresponding QuestMap graphical icons. The elements as well as other external documents may be related using hypertext links. The system provides a graphical view of the way the conversational map (icons and their relations) is evolving. Conversational maps created with QuestMap may be stored for future consultation on these meetings. For instance, it is possible to learn why a particular decision was made in a certain meeting, or what really happened in a meeting. It is also possible to determine the participants in a certain meeting and the way a group reached consensus. The discussion map in QuestMap can provide a decision making process view to someone who did not attend the meeting.

Another interesting system is ***SHAMAN*** [3] which supports knowledge construction in "material practice" (for example, a paper mill). This knowledge can be used in remembering, reusing and interpreting recurring similar situations. The idea is to foster the sharing of these knowledges and experiences among different process control roles over long times.

The ***Virtual Participant*** system [16] was developed for computer supported collaborative learning environ-ments to manage discussions on some lesson topics. The system lets users store the most relevant aspects of previous discussions and makes them available in the context of a new discussion.

Knowledge Sharing Environment (KSE) [9] provide "closed user groups or communities" with an environment which enables them to more easily share both explicit and tacit knowledge. KSE assigns each user to an agent, which manages a user profile incorporating information the user needs or over which he is interested. The agent filters information obtained from the database, according to the profile defined by the user.

4. Memory from a cognitive science point of view

In this section we review some aspects of human memory and its possible implications for the design of an OM. The first distinguishing feature of human memory is the clear separation of Short Term Memory (STM) from Long Term Memory (LTM).

STM retains immediate *interpretations* of sensory events. If the person has just heard a sentence, he does not hear the sounds but he remembers the words. The capacity of this memory is limited: only the last five or six items that have been received can be retained. The person can consciously repeat the material to himself, keeping it in STM for an indefinite amount of time. This *rehearsal* of items is the most characteristic feature of STM.

Typical OM models do not have STM similarities. One may suggest that incorporation of knowledge to an OM could take STM features and processes into account. In fact, the selection of relevant knowledge could have an initial interpretation, i.e., transformation for useful assimilation. For example, a discussion being held by employees could be filtered out of elements related to day-to-day conversations but not useful for long term storage. Rehearsal offers another interesting metaphor: perhaps ideas which are mentioned several times in a discussion are useful to be selected for persistent storage.

Long Term Memory has several features to inspire OM design. One of them is that LTM is an associative memory. Try to remember, for instance, the orientation of the window of the bedroom you used in your previous home. It is almost certain your memory has not literally stored "the window in the bedroom of my previous home faced north (or any other direction)". Instead, you probably remember some clues enough to deduce the orientation, such as the side of the home where sunrise could be observed, the position of your bedroom in that home, etc. An OM could benefit from having associative processes instead of just facilities to search by keywords or text strings.

Another interesting LTM feature is forgetting: apparently useless information is increasingly getting less and less accessible; by contrast, knowledge which is supposed to be more useful is easier to remember. Some attempts have been done in artificial systems to try to provide the most relevant answers first in response to a query, e.g., by Web searchers [4]. The same characteristic could be included in OM systems. Forgetting could not only take place when filtering information for presentation but in the storage/retrieval structures and processes: retrieval could be faster and easier for *recent* information and slower and more difficult for old knowledge; recency can be defined by expected relevance to the user.

A third LTM feature worth of consideration is reorganization. In human LTM memory, new information is always being related to the previous knowledge, which in turn is restructured. Thus, children tend to associate words which sound alike while adults make associations based upon meaning [18]. In an OM this could be incorporated not necessarily as the physical movement of information but as dynamic associative structures: new knowledge can change old relations and create new ones.

Finally, not only similarities between human memory and OM could be examined, but also their differences. One important difference is that while retrieval in human memory is for only one "user", retrieval in OM can be for many and eventually all employees of the organization. This poses great privacy challenges which are inexistent in human memory. Suppose, for instance, computer-mediated discussions such as those mentioned in [5] are saved for incorporation into an OM (the same observation may be applicable to e-mail conversations). People may not be willing to accept unrestricted later retrieval of their comments, because perhaps it will be performed by unknown people and out of context.

5. Yet another model

Conklin mentions three technologies which must be included in a computer system in order to implement an OM: hypertext, groupware, and a rhetorical method (also called a conversational model) [6]. The groupware system allows information capture while users work. The hypertext provides an efficient way to organize and display the information, for example through the Wide World Web. The conversational model structures information according to the contents and provides context.

We have developed an asynchronous distributed meeting preparation system called WSISCO [19] taking into account the idea that OM can be captured in the context of cooperative work. WSISCO is a Web-based system and it is useful to manage structured discussions on the agenda items to be included in a decision-making meeting. WSISCO discussions are structured according to the SISCO [5] conversational model, which is IBIS-based. Besides IBIS issues, positions and arguments, SISCO incorporates pre-decisions, proposals, tasks, remarks and InfoBase. Pre-decisions are assumptions or common agreements made beforehand; a proposal is an issue specialization used to suggest a task to be carried out; a task is the description of an activity to gather some additional data needed for the rest of the discussion; this extra data is stored in the InfoBase; finally, the remarks are statements which do not clearly fit in the other elements. Furthermore, a SISCO discussion is organized as a hierarchy. The chapters of the discussion are the *agenda items.* Each item has a set of *objectives,* each of which has a set of discussion elements (issues, proposals, etc.).

Up to this point, we are using the three technologies suggested by Conklin to build an OM: a groupware system (meeting preparation), a rhetorical method (SISCO, and a hypertext-based system (WSISCO). However, this is not enough to have a KMS since it is difficult to do meaningful searches in the stored information. Moreover, some of the information provided by users in this type of applications, could be labeled as "confidential", or "private". Our claim is that Conklin's proposal for implementing an Organizational Memory (hypertext, groupware and rhetorical method) lacks two essential elements: an *information retrieval* system [11] and mechanisms to provide *privacy* to the users contributing the information contained in the OM.

We developed a system called OMUSISCO [19] to provide an adequate way to retrieve knowledge stored in WSISCO discussions. OMUSISCO uses modern information retrieval techniques [4] to access both the information requested by the user and the context of the pre-meeting where this information was generated. This is not exactly a KMS as defined by Lehner and Maier. We actually have two systems sharing the same databases: a groupware system which captures, retains and maintains information, and another software implementing search and retrieval. The latter software system can not be labeled as collaborative (it does not have to be collaborative!).

To the question "What do organizations need to remember?", Conklin answers: *decisions and the knowledge surrounding them* [7]. This can then be achieved with the use of WSISCO to prepare decision-making meetings, and OMUSISCO to search and retrieve the context. Nevertheless, we have not solved yet the privacy problems.

Concerning privacy, OM systems present an important new scenario: information provided by people -including personal opinions, comments, etc.- may be stored for unlimited periods of time. Potentially, that information may be extracted and used afterwards out of context by other unanticipated people. Some of these uses may be legitimate but others may be unethical and undesirable. Consider, e.g., the case of a manager who may fire employees by comments made in a conversation stored months ago. Of course, conversations via electronic mail messages have long been available; the new scenario is that the OM is a resource available to the whole organization, with structured stored information and with special retrieval facilities. Should the access to the OM be restricted? Should people contributing to an OM refrain to make any personal statement which could be used against them afterwards? Could the KMS have some built-in features to help keep contributors' privacy?

There are three possible scenarios concerning privacy of this information: first, access to the OM is guaranteed to be only for people participating in the discussions; second, people are not told their discussions will be stored in the OM; and third, people are aware beforehand that all discussions will be part of the OM.

The first scenario significantly reduces the benefits of the OM, since the stored knowledge can not be accessed by many legitimately interested people. It also has the problem that the restricted access may be violated afterwards by technological means or by administrative authority.

The second scenario seems clearly unethical: information voluntarily provided by people can not under any circumstances be used for other purposes. This is similar to the ethical issue posed by organizations selling personal data; nowadays this is considered unethical and is punished in many legislations.

The third scenario can lead to a situation where users might be afraid to say anything because it may be used afterwards against them in another context. We have called this situation "the Nixon's syndrome" (in reference to the famous voluntarily recorded tapes from conversations by former US President R. Nixon himself during the Watergate trial).

On the other hand, the goal of a KMS is to gather all information provided by users in order to reuse it in the future. Perhaps the main problem is in the author-information link, i.e., "who said what". If we are able to cut this link we may have part of the whole issue settled, since a stored information could not be used against its author. Making a similarity with the Watergate case, it is like the recorded tapes were found, but no one could prove a certain voice was Mr. Nixon's.

One approach to separate the information from its author is *anonymity*. In fact, several tools are available to help people browse the Web anonymously. For example, the Anonymizer (http://www.anonymizer.com), the Crowds system (http://www.research.att.com/projects/crowds), and the Lucent Personalized Web Assistant - LPWA (http://www.lpwa.com). These systems are intended to provide anonymity to users who navigate the Web, but of course, they do not solve our problem of stored information in the OM.

A problem with anonymity is that it is not always convenient to have it. In our meeting preparation system, in particular, one of the functions of the facilitator is to motivate users to participate and contribute to the discussion. This task is made less effective if all or most of users' contributions are anonymous, since the facilitator can not know the number of contributions from each person. This problem relates to the *free riding* reported in the literature [17]. One partial solution is to make the system count the number of contributions for their authors in spite of being anonymous; the solution is only partial, because the anonymity turns out not to be total: in some cases it will be possible to identify or quasi-identify the author.

A second solution to separate a contribution from its author's name is to use *aliases.* This solution has the advantage a facilitator can be aware a certain alias is not contributing much and can send an electronic message to motivate him. Nevertheless, it is not useful to reward a person who has made a great contribution.

A third approach to break the "who said what" relation is to introduce a name forgetting function in the system. This function is a metaphor of a real situation: when remembering a conversation held some time in the past one typically reminds someone said something but can not recall the author. This approach has the desirable feature of having the time in which the authorship is maintained as a parameter; after this period, authorship is forgotten. Moreover, each person can individually set this parameter to his own liking, including the possibility of never forgetting.

The advantage of this approach - besides the similarity to unsupported conversations - is that names are available for a short period in which they may be necessary (for instance, to grant rewards for significant contributions or dedication), but afterwards, privacy is ensured by deleting reference to names if so desired by the people themselves.

Finally, a fourth approach is to provide a series of retrieval filters by user type. The type of the user may be defined according to profiles. The filtered information may not include authors' names, part or all of the discussion. For instance, group members participating in the discussion may have full access, but management may not be allowed to get names. The problem with this approach is that full information is stored and is therefore vulnerable to be fraudulently accessed by other programs or using privileged codes or passwords.

These four approaches to privacy represent *pure strategies*. For a particular implementation they may be combined to develop a practical system. Thus, answers to the questions to the users we mentioned above may serve to orient the choice of strategies to use. In our current WSISCO version, users may enter the system using an alias. In the WSISCO first screen the user is asked his login identification and password in order to access his profile including his role and privileges. He may optionally provide an alias. In case the user creates an alias, all contributions done in this work session will be attributed to the alias. Furthermore, any contribution can optionally be done anonymously. This is a real example combining three pure privacy strategies: anonymity, alias and user profiles. In the next version of WSISCO – under construction – users will be able to choose the period after which the system must forget his name or alias.

Design and implementation of a KMS may be based on a collaborative activity, a conversational model and hypertext, a search and retrieval module, and privacy strategies. In turn, the embedded information retrieval system must worry about the privacy concerns. A model for the development of a complete KMS must include these five components (see Figure 5).

Four pure privacy strategies were proposed with no claim about completeness: other strategies may be suggested. The proposed ones are: anonymity, aliases, user profiles and scheduled forgetting. They can be analyzed according to their effectiveness level and applicability period; they also allow different degrees of collaboration support (see Table 1).

Table 1 includes the case of no privacy strategy just for comparison. When using anonymity, the privacy level is very high because the "who said what" link is completely broken; this also makes the applicability

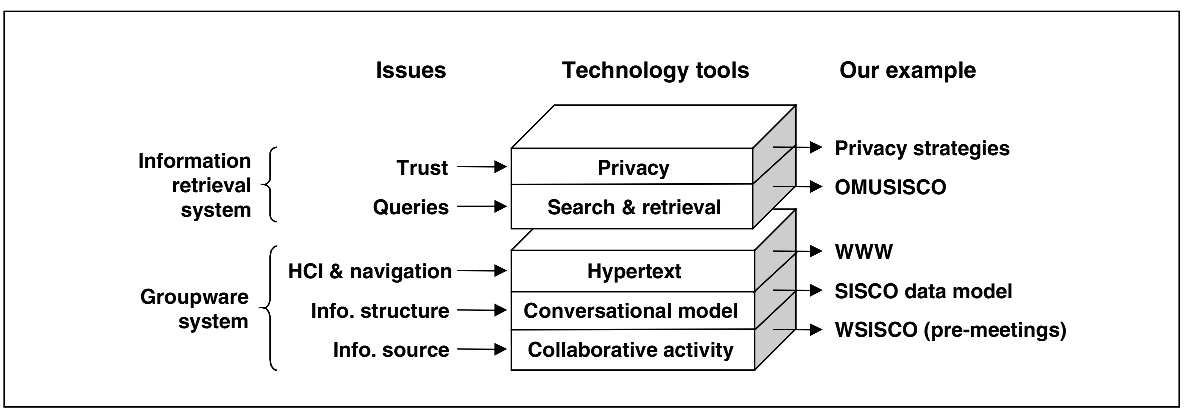

Figure 5. A five components model proposed for a KMS

Table 1. Pure Privacy Strategies

Strategy	Privacy level	Applicability period	Collaboration support
No privacy	Zero	None	Very high
Anonymity	Very high	Always	Very low
Aliases	Average	Always	Low
User profiles	Low	Short time	Very high
Scheduled forgetting	High	Mid to long term	Very high

period be infinite. However, anonymity does not support collaboration, since any user does not know the names or even the number of other people with whom he is working. The use of aliases provides a high level of privacy, because it would not be possible to prove a certain person corresponds to a given alias.

For collaboration purposes, the use of aliases lets a person know the number of people with whom he is interacting but not their identities. User profiles give information about group members, but the privacy protection is low, since a system administrator may get to the "who said what" information, since the link is not really broken: it is just selectively hidden. The privacy enforcement may not last long, since there may occur a change of management in the organization, for example. Finally, the scheduled forgetting provides an adequate level of privacy, being the user who decides when is the "who said what" link to be broken. This mechanism also supports collaboration, because group members have all information about their peers available during the interaction period, assuming forgetting occurs after the discussions are closed.

It is possible to include more than one pure strategy in a particular system, thereby enhancing their strengths and reducing their weaknesses. It will depend on the particular system and their future users the choice of privacy strategies to implement.

6. Conclusions

Organizational Memory has several definitions in its twenty-years since this term was introduced. Some of the terms used in the theoretical models may be too general, such as "knowledge needed in the organizations". However, they are useful to develop actual systems which may be used within companies or institutions.

The paper has examined some of the most interesting OM models and some of the developed systems to support OM as well. It has also briefly reviewed the original inspiration for OM: human memory. A few design ideas can be obtained from such review.

Then, a new model for OM consisting of five components is presented. The contribution of this model is the fifth component (privacy) which somehow has been absent from previous works on OM. Some pure strategies to provide privacy to OM contributors are presented. These strategies may be combined in an actual implementation.

One such implementation is under way. WSISCO is being built again with a new name, PRIME, for a large corporation. It will have some built-in privacy strategies according to real user demands in provision for the databases which will be accessible with a new version of OMUSISCO.

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References

[1] Abecker, A., Sintek, M. and Wirtz, H. "From Hypermedia Information Retrieval to Knowledge Management in Enterprises". Proceedings of IFMIP'98, First International Forum on Multimedia & Image Processing. Anchorage, Alaska, USA. May, 1998.

[2] Ackerman, M.S., McDonald, D.W.: "Answer Garden 2: Merging Organizational Memory with Collaborative Help". Proceedings of the CSCW'96, ACM Press, Massachusstts, USA, November 1996, pp. 97-105.

[3] Auramäki, E., Robinson, M.,Aaltonen, A., Kovalainen, M., Liinamaa, A., Tuuna-Väiskä, T.: "Paperwork at 78kph". Proceedings of the CSCW'96, Massachusetts, USA, 1996, pp.370-379.

[4] Baeza-Yates, R., Ribeiro-Neto, B.: Modern Information Retrieval. ACM Press, New York, and Addison-Wesley, Harlow, England, 1999.

[5] Borges, M.R., Pino, J.A., Fuller, D.A., Salgado, A.C.: "Key issues in the design of an asynchronous system to support meeting preparation". *Decision Support Systems* 27, 1999, pp. 269-287.

[6] Conklin, E.J.: "Capturing Organizational Memory". Readings in Groupware and Computer-Supported Cooperative Work, R.M. Baecker (Ed), Morgan Kaufmann, San Mateo, California, 1993, pp. 561-565.

[7] Conklin, E.J.: "Designing Organizational Memory: Preserving intellectual assets in a Knowledge Economy". http://www.gdss.com/DOM.htm

[8] Conklin, E.J., Begeman, M.: "gIBIS: A Tool for All Reasons". *Journal of the American Society for Information Science* 40, 1989, pp. 200-213.

[9] Davies, N.J. Stewart, R.S., and Weeks, R. "Knowledge Sharing Agents over the World Wide Web". *British Telecom Technology Journal*. 16(3), 1998, pp. 104-109.

[10] Hedberg, B.: "How organizations learn and unlearn". In Nystrom, P.C. and Starbuck, W.H. (eds.): Handbook of Organizational Design. New York/Oxford, 1981, pp. 3-27.

[11] Kimbrough, S.O. and Oliver, R. "On relevance and two aspects of the corporate memory problem". Proceedings of the Fourth Annual Workshop on Information Technologies and Systems (WITS), 1994, Vancouver, B.C., Canada, pp. 302-311.

[12] Lehner, F., Maier, R.K.: "How can Organizational Memory theories contribute to Organizational Memory Systems?". *Information Systems Frontiers* 2: 3/4, 2000, pp. 277-298.

[13] Lindsay, P.H., Norman, D.A.: Human Information Processing – An Introduction to Psychology. Academic Press, New York, 1973.

[14] Mandviwalla, M. and Grillo, P.: "TeamBox: An exploration of collaborative interoperatibility". Proceedings of the Conference on Organizational Systems (COOCS'95), ACM Press, Milpitas, CA USA, 1995, pp. 347-353.

[15] Mandviwalla, M., Grillo, P. Supporting the Evolution of Teams With Transactions: A Design Architecture for Organizational Memory Systems. *Journal of Organizational Computing and Electronic Commerce* 9(2&3), 1999, pp. 171-187.

[16] Masterton, S.J. "The Virtual Participant: Lessons to be Learned from a Case-based Tutor's assistant". Procedings of the Conference on Computer Supported Collaborative Learning, Toronto, Canada, December, 1997.

[17] Nunamaker, J.F., Dennis, A.R., Valacich, J.S., Vogel, D.R., George, J.F.: "Electronic meeting systems to support group work". *Communications of the ACM* 34 (1991), 40-61.

[18] Posner, M.I.: The Foundations of Cognitive Science, MIT Press, Cambridge, MA, 1993.

[19] Romero, N.A., Pino, J.A., Guerrero, L.A.: "Organizational Memories as electronic discussion by-products". Proc. of Sixth International Workshop on Groupware (CRIWG'2000), Madeira, Portugal, Oct. 18-20, 2000. IEEE Computer Society Press, Los Alamitos, CA, pp. 11-18.

[20] Schwartz, D.G, Divitini, M. and Brasethvik, T. "On Knowledge Management in the Internet Age". Internet-Based Organizational Mamory and Knowledge Management. Schwartz, D.G, Divitini, M. and Brasethvik, T., eds. Idea Group Publishing. Hershey, USA, 2000.

[21] Stein, E., Zwass, V.: "Actualizing Organizational Memory with Information Systems". *Information Systems Research* 6(2), 1995.

[22] Walsh, J.P. and Ungson, G.R.: "Organisational Memory". *Academy of Management Review* 16(1), 1991, pp. 57-91.

[23] Watson, R.T.: Data Management. Databases and Organizations. John Wiley & Sons, Inc. Second Edition, New York, 1998.

[24] Wegner, D.M.: "Transactive Memory: A Contemporary Analysis of the Group Mind". Theories of Group Behaviour. Mullen, B. and Goethals, G.R., eds. New York, 1986.