Enabling Knowledge Management of Organizational Memory for Groups Through Shared Topic Maps

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Abstract
Managers are challenged to deal with ever increasing and interconnected web of knowledge and information. Competing for attention in an information rich environment requires the use of efficient mechanisms to abstract the underlying knowledge extracted from collaborative tasks and myriad sources. Moreover, building capabilities to access and reuse the knowledge is also important. The recent push toward service oriented architectures and enabling technologies have refocused attention on knowledge management and organizational memory. Managers and users rely on a variety of information and knowledge from many sources. Their ability to access, use, and repurpose the knowledge is critical, especially when decisions are made at the group and organizational level. Topic maps based systems provide a vehicle to carry out a solution. At group levels, the topic map supports dynamic changes to the structure through collaborative search and modification capabilities. We present a model of a topic map based system that uses these theories and illustrate its use by way of supporting a group search implementation. A prototype of the model is briefly discussed.

Keywords
Knowledge management, group decisions, group search, organizational memory, topic maps.

1. Introduction
In recent years, organizations have become more attentive towards the use of a varied collection of information and knowledge in support of decision making. Decisions are made at the personal, group, and organizational levels in organizations and as Hackathorn and Keen (1981) suggested systems are often built to support these objectives. Courtney (2001) argued for an expanded view, based on the Singerian philosophy of inquiry, of decision support where a myriad of knowledge resources are employed in innovative ways. Eom and Kim (2006) conclude from their survey of decision support system (dss) literature that in spite of the advances in technology and diffusion of dss capabilities at all levels of an organization, more efforts need to be made to develop theories, tools, techniques that can be applied in the development and implementation of DSS and that can meet the needs of practicing managers.
An issue at the core of knowledge management is how to organize and access the rapidly expanding repository of information and knowledge. Organizations might view these repositories as collections of organizational memories. Further these repositories are useful in building digital dashboards that display key performance metrics for the organization’s core processes. Visual accesses to business process performance metrics through digital dashboards and the ability to extract nuggets of knowledge have received executive attention. A key concept here is the availability and use of relevant information categorized into topics that are associated with the processes which key actors find valuable.

We present model of a topic map based system that employs these theories and illustrate its use by way of supporting a group search implementation.

2. Organizational Memory and Knowledge Generation

Organizational memory (OM) is a stored collection of organizational history reflected among the many parts (Walsh and Ungson 1991). It includes stored records and tacit knowledge and covers the various facets of organizational tasks, employees, and their task environments (Argote et al. 2003, Lee et al. 1999, Nonaka and Konno 1998). Because it can be a large and valuable repository of information and knowledge, several researchers have recognized the import of organizational memory in effecting organizational performance (Akgun et al. 2006, Brockman and Morgan 2003, Jennex and Olfman 2002, Ji and Salvendy 2004, Lesser and Storck 2001).

A goal of organizational memory systems is to enable sharing of knowledge among work groups. Cummings (2004) found that performance of the group increased when the structurally diverse work groups shared their knowledge externally. Sharing of knowledge at the group level requires adequate organizational incentives in the form of administrative and organizational innovations as well as technical capabilities as offered through technical innovations (Malhotra and Majchrzak 2004, Small and Sage 2006). Huysman and Wulf (2006) suggest that in order to improve knowledge sharing information technology (IT) tools need to be embedded in the social networks of which it is part. Topic maps are examples of IT tools.

2.1. Topic Maps

Topic maps provide a subject based classification of resources where each resource represents a real world object or tool. In topic maps, three constructs are provided for describing the subjects represented by the topics: names, occurrences, and associations. These describe the names, properties, and relationships of subjects, respectively. A name may be assigned to more than one topic and a topic may have more than one name. Also by defining scope and types a name can become rich and complex. An occurrence links to one or more real knowledge sources. An occurrence, however, is not part of the topic map. Associations describe relationships among topics and are independent of the real knowledge objects. Associations add value through the relationships. The ISO standard ISO/IEC 13250 provides a standardized notation for interchangeably representing information about the structure of information resources used to define topics, and the relationships between topics. A set of one or more interrelated documents that employs the notation defined by this International Standard is called a topic map. The standard further states that a topic map defines a multidimensional topic space — a space in which the locations are topics, and in which the distances between topics are measurable...
in terms of the number of intervening topics which must be visited in order to get from one topic to another, and the kinds of relationships that define the path from one topic to another, if any, through the intervening topics, if any.

The Topic Map architecture is designed to help merging topic maps without needing the merged topic maps to be copied or modified. This feature makes it suitable for use in organizational memory systems. As Steiner et al. (2001) state, constructing large, complex organizational memories takes place over extended periods of time, growing incrementally both in size and structure. The ISO standard describes how topic maps may be used in situations such as that may be found in OM systems. For example, a topic map can be employed “to structure unstructured information objects, or to help create topic-oriented user interfaces that provide the effect of merging unstructured information bases with structured ones (Ramalho et al. 2006). The overlay mechanism of topic maps can be considered as an external markup mechanism, in that an arbitrary structure is imposed on the information without changing its original form.” Knowledge management applications can also benefit from topic maps, especially when combined with ontologies (Tsampoulatidis 2004). Korthaus et al. (2006) describe a topic grid architecture that enables a client application to view distributed topic maps of organizational knowledge as a combined virtual topic map. Each distributed topic map represents a different view of the underlying information.

Smolnik and Erdman (2003) state that topic maps provide strong paradigms and concepts for the semantic structuring of link networks and therefore, they are a considerable solution for organizing and navigating large and, continuously growing organizational memories. Miller et. al (2007) developed a model of a topic map based OM knowledge management system to represent and use organizational memory artifacts.

In the following sections we describe a model of topic map implementation that addresses the collaborative aspect of process management and group support.

3. Model

We expand on the model we presented in Miller et al. (2007). In that model, the use of topic maps was limited to one user with no provisions for incorporating topic maps from other users nor did the model allow knowledge growth.

The goal of any organization is to make best use of the business knowledge that it has accumulated over the years. To do this, it is necessary to determine the sources of business knowledge and provide members of the organization access to all sources in a timely matter. Here we focus on the latter issue of providing access through retrieval, analysis, merging, modifying, and learning tools. As with our orginal model, we also assume that business knowledge sources are employee knowledge, transaction data, data warehouse data, memory artifacts (internal and external), and the knowledge inferred from these sources.

3.1. Topic Maps

A topic map is used to provide users with visual to both search and analysis. It is this interesting blend of semantic search and analysis that motivates its use in the proposed model.

Here we define a topic map to be the directed acyclic graph $\mathcal{T} = (\mathcal{N}, \mathcal{E})$, where $\mathcal{N}$ is the set of topic map terms, data types, or search/analysis tools. The directed edges in $\mathcal{E}$ are of the type $(n_1, n_2)$, where
n₁ is a topic map term or a data type and n₂ is a topic map term, a data type, or a search/analysis tool. An implicit node, called the root, points to the topic map terms, data types and/or tools that make up the first level of the topic map. Nodes with out degree zero are said to be leaves of the topic map. Leaves point to the information in the organization’s memory and carry any search terms and/or data types accumulated on the path from the root of the topic map to the leaf. Note that leaves that are either search terms or data types make use of an implicit search tool or a list of resources. In addition each non-leaf level of the topic map has a search tool that can be used to initiate a search based on the topic map terms that have been traversed to get to the current topic map level.

A visual topic map over a topic map $T = (N,E)$ can be seen as a directed acyclic graph $V = (S,A)$, where $S$ is a set of screens and $A$ is a set of directed edges that connect the screens via a node context. A screen $s \in S$ is defined as 2-dimensional representation of a set of nodes $S_N$ such that each node $m$ in $S_N$ is in $N$ and there is a node in $n \in N$ such that $(n,m) \in E$ for every $m$ in $S_N$. An edge exists in $A$ whenever a non-leaf topic node on one screen points (in $T$) to the nodes on the second screen. The root node described in the topic map definition above is replaced by the screen representing the nodes in $T$ that are adjacent to the implicit root node. Each edge in $A$ has a node context. This node context implies selecting a non-leaf node on a screen results in following the link to the screen associated with the node. Figure 1 illustrates a screen shot of a screen in the current prototype.

![Topic Map Search Environment](image)

Figure 1. Screenshot showing a screen in a visual topic map.

### 3.2. Process and Group Topic Maps

The proposed model makes use of two types of topic maps, namely a Process Topic Map and a Group Topic Map, as a means of managing users’ access to the knowledge available to the organization through its organizational memory.
3.2.1 Process Topic Map

The Process Topic Map is defined by the pair \(<V, p>\), where \(V\) is a visual topic map and \(p\) indicates the business process on which the topic map has been constructed. The path label of node in a topic map indicates the union of the topic terms from the root to the node. Actors and roles are associated with each process. The roles include process owner, process manager, and process participants, where each one has different knowledge requirements. From a user’s point of view the structure of the Process Topic Map is fixed. The motivation for using such a static view of the Process Topic Maps is that they have been designed to provide support for individuals working on processes that are defined on an organization wide basis. The one deviation from this approach is based on the level of users. When building a topic map, one has to make a decision concerning who is the target audience. The main question is how to deal with the experience range of the users. For a topic map to be useful to a novice user, it is necessary that it has a sufficiently fine granulation so that the novice user will be able to make use of the topic map. The result is that experienced users will have to waste time moving down through the screens in order to get to the topics and/or tools that they need to use. To bridge this gap, we have introduced the notions of a shortcut node and a corresponding shortcut screen. As a user gains experience in working with a process and the related topic map, he/she can make shallow copies of topics and/or tools and place them on the shortcut screen. For convenience, we have placed the shortcut node on the first user screen. The user simply has to indicate the desire to create a shortcut for the node. In our current prototype, the user right clicks on the node to make the copy. The node’s path label and screen link (for non-leaf nodes) are copied to the shortcut screen along with the node. As a result, the experienced user can have access to any topic and/or tool without having to traverse the topic map. As the needs of the user changes they can delete any nodes that they no longer need access to. The model supports one individualized shortcut screen for each Process Topic Map that a user has access to. Although a novice user may navigate the map from its “root”, an expert user might want to use a “shortcut” screen. The shortcut screen provides quick access to the part of the topic map structure that the user often uses. The shortcut screen would include nodes where each node might be a path to further levels of the topic map or calls to various tools and services. The process topic map and the user’s (actor/role) view of the topic map persist in the system.

3.2.2. Group Topic Map

While Process Topic Maps are useful for individuals working on the processes that they have been assigned, group tasks (e.g., committees) that bring together people from across the organization require an approach to managing knowledge for the group. To deal with these concerns, our model introduces the concept of a Group Topic Map. A Group Topic Map is defined by the 4-tuple \(<V, G, O, R>\), where \(V\) is a visual topic map, \(G\) is the group of users, \(O\) is the set of operations defined on \(V\), and \(R\) is the set of roles relevant to the group’s mission.

The visual topic map in a Group Topic Map has properties similar to the visual topic map in the Process Topic Map. The basic definition of a visual topic map remains unchanged. It incorporates the shortcut node and screen for the same reasons given above. The primary difference is that the notion of a path label is weakened in this version of the visual topic map. The motivation for this difference is that it gives the model the opportunity of making use of the users’ understanding of their areas of work and skills. It gives them the ability to place nodes on screens that they feel will provide the best information for other members of the group. To this point, we have assumed that everyone in the group can use all of the operations in \(O\), but our prototype could easily be extended to restrict who can make the changes and limit the kinds of operations that individual users can perform.
The initial visual topic map would be up to the group. It could simply be an empty initial screen, a
topic map that exists based on prior efforts of the group, or a topic map that is created by members of
the group using the operations available in the operation set. The choice would be up to the group
and/or the organization at large.

In the remainder of this section, we describe the components of the model.

3.2.3. Group
The group represents the set of members of the group. In our current model this is simply a list of the
people that can use and manipulate the Group Topic Map. It could easily be extended to include
information on privileges assigned to the individual members of the group.

3.2.4. Operations
The operations (O) defined for the Group Topic Map operate on the nodes of the topic map. The focus
of the operations is to allow the individual members of the group to impact the group’s access to the
organization’s knowledge by modifying the group’s search process through changes in the Group
Topic Map set up to support the group’s use of organizational knowledge. The basic operations
available to members of the group are:

AddANode – The operation allows users to copy nodes from the process based topic maps (i.e., the
individual topic maps) based on the processes that the user has access to for their non-group activities.
The user indicates to the system that he/she wishes to copy a node from a Process Topic Map into a
Group Topic Map. The system responds by giving the user the choice of the Group Topic Map that
he/she wants to add the node to. The user is then asked to choose the screen that he/she would like to
add the node to. The node and its descendents (if any) are copied to the screen along with their current
path labels and screen linkage.

CreateANode – This operation is used to add new knowledge to the Group Topic Map. Where as, the
AddANode operation copies an existing node and its associated knowledge into the Group Topic Map,
the CreateANode is used to add either newly created or synthesized knowledge. It is well-known that
there is always a difference between the true organizational memory knowledge (TOM) and the
accessible organizational memory knowledge (AOM). The gap, TOM - AOM includes knowledge
that is hard to capture as well as knowledge that is sufficiently new that it has yet to be captured. The
CreateANode operation allows a user to capture some of this knowledge and provide access to it
through the Group Topic Map.

GeneralizeANode – This operation is designed to allow users to partition the knowledge space
indicated by the semantics of a node. It is used when the user sees the need for a finer level of detail in
dividing the knowledge space. The operation creates a new screen and the edge that connect it to the
node that has been generalized. The user can then add nodes to the new screen by using either of the
previous two operations.

SpecifyANode(Role) – Whenever a user copies a node from a Process Topic Map, the node is
associated with knowledge that is focused at least to some extent on the underlying process. To
provide a broader interpretation, the operation takes a role and creates a new node that reflects the
underlying concepts of the original node while incorporating the role. For example, the system can
use the existing knowledge indicated by the original node combined with the definition of the new
node to search the knowledge space. The results of the search would reflect knowledge more skewed to the new role.

ModifyANode – This operation would allow the user to modify properties of a node. In our current model, this could result in changes in the value of the topic indicated on the screen or changes in the path label associated with the node.

MoveANode – The motivation is to allow users to move nodes to another screen to enhance the use of the node in the group search process.

DuplicateANode – This operation allows a node to be duplicated on another screen. Note that the new node is only a shallow copy of the original node and takes with it any screen links and path labels.

DeleteANode – As nodes become irrelevant or dated, this operation allows users to delete extraneous nodes.

3.2.5. Roles

The roles in R are the roles of the members of the group that are relevant to the task that the group is charged with. The set restricts the way some of the operations (e.g., SpecifyANode) work and also add information to potential searches required for operation on individual nodes.

4. Current Prototype

The current prototype allows the user to have access to multiple Process and Group Topic Maps. The implementation uses a logon id and password to determine the list of topic maps that a user can access.

Our current prototype provides a complete implementation of Process Topic Maps as described in the previous section. Figure 2 shows the initial screen of a Process Topic Map based on the Federal Reserve Monetary Policy process. The node shown with the Short Cut label points to the shortcut screen. The user can personalize it by adding any nodes from deeper levels in the topic map. The user can clean up the shortcut screen by deleting nodes. The copy is a shallow copy that simply points to the node.

The implementation of the Group Topic Map supports all of the operations defined in the previous section except for the SpecifyANode and CreateANode operations. The user can open a window for each of the topic maps that they have access to. For operations such as DeleteANode, ModifyANode, MoveANode, and DuplicateANode, the user operates directly on window that represents the Group Topic Map. He/she simply clicks on the node in question and chooses the appropriate operation from the menu. The AddANode operation is a somewhat more interesting case. It requires that the user have both the Process Topic Map screen window and the Group Topic Map windows open. The user starts the operation by clicking on the node and choosing the copy to a Group Topic Map option. The prototype then expects the user to go to the Group Topic Map window and find the screen that he/she wants to add the node to.

The prototype has been built in Java using Java graphics to dynamically draw the individual screens. The two primary classes (Screen and Node) are stored on the server [Miller et al. 2007] in a database based on Hibernate built over MySQL. The prototype runs on the client side and communicates with the server using the SOAP protocol.
To implement the shortcut screen and the group screens, the prototype makes use of classes that are extensions of the Screen class. This approach has been used to simplify the handling of the screen types and to add the extra functionality required. In a similar fashion, Topic and Tool classes are used to extend the Node class.

4. Conclusions and Future Directions

Managers are challenged to deal with ever increasing and interconnected web of knowledge and information. Competing for attention in an information rich environment requires the use of efficient mechanisms to abstract the underlying knowledge extracted from collaborative tasks and myriad sources. Moreover, building capabilities to access and reuse the knowledge is also important. Their ability to access, use, and repurpose the knowledge is critical, especially when decisions are made at the group and organizational level. Topic maps based systems provide a vehicle to carry out a solution. At group levels, the topic map supports dynamic changes to the structure through collaborative search and modification capabilities. We presented a model of a topic map based system that uses these theories and illustrate its use by way of supporting a group search implementation. Our prototype implementation showed how topic maps are used at process levels and group levels.

The next generation of the prototype will expand the implementation of the Group Topic Map operations. An ongoing issue is to expand the number of tools. We are also looking at methods to simplify the introduction of new tools into our complete system. Finally, development of a comprehensive prototype will allow us to test the model in an industrial or agency setting.
References


